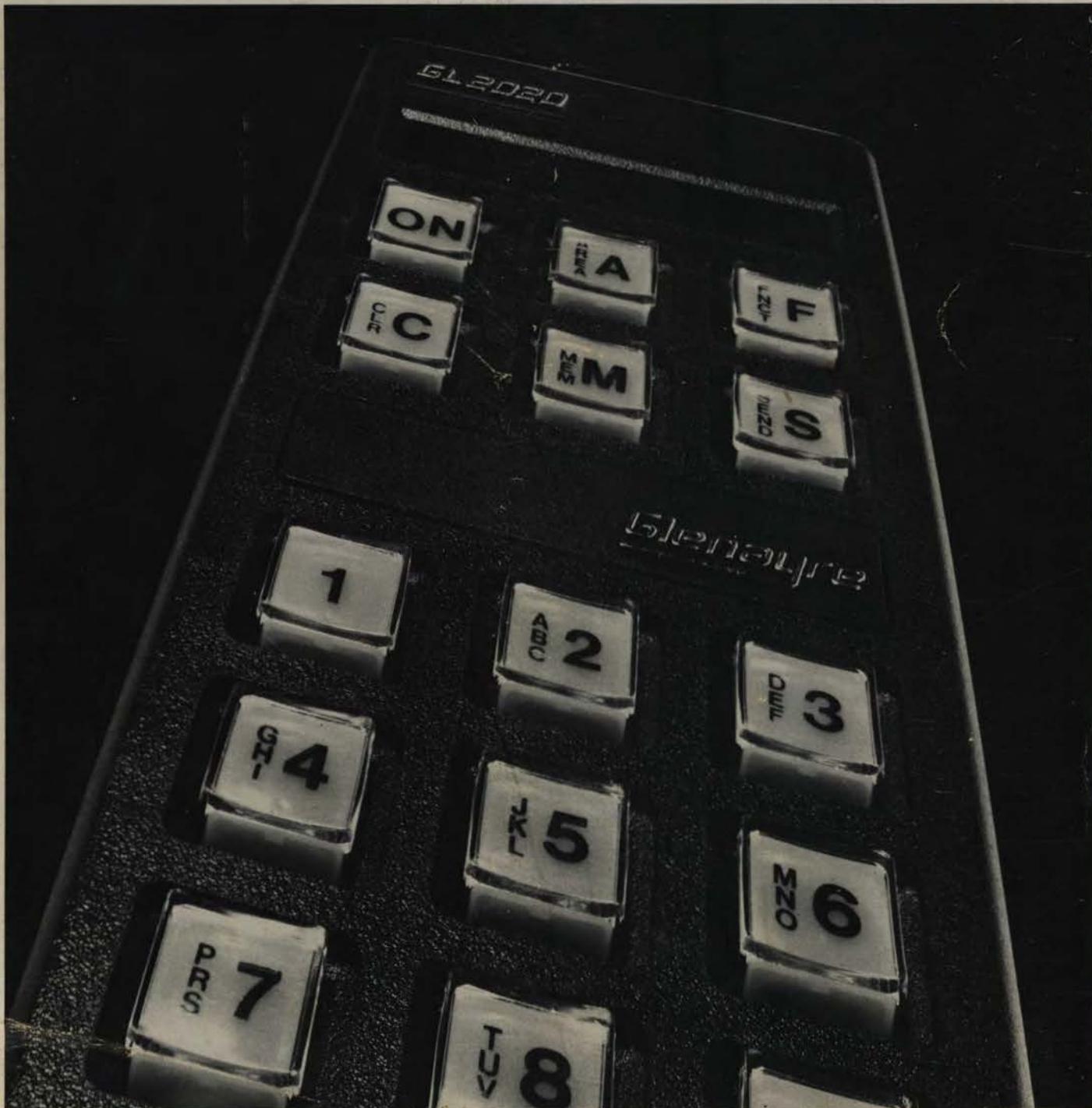
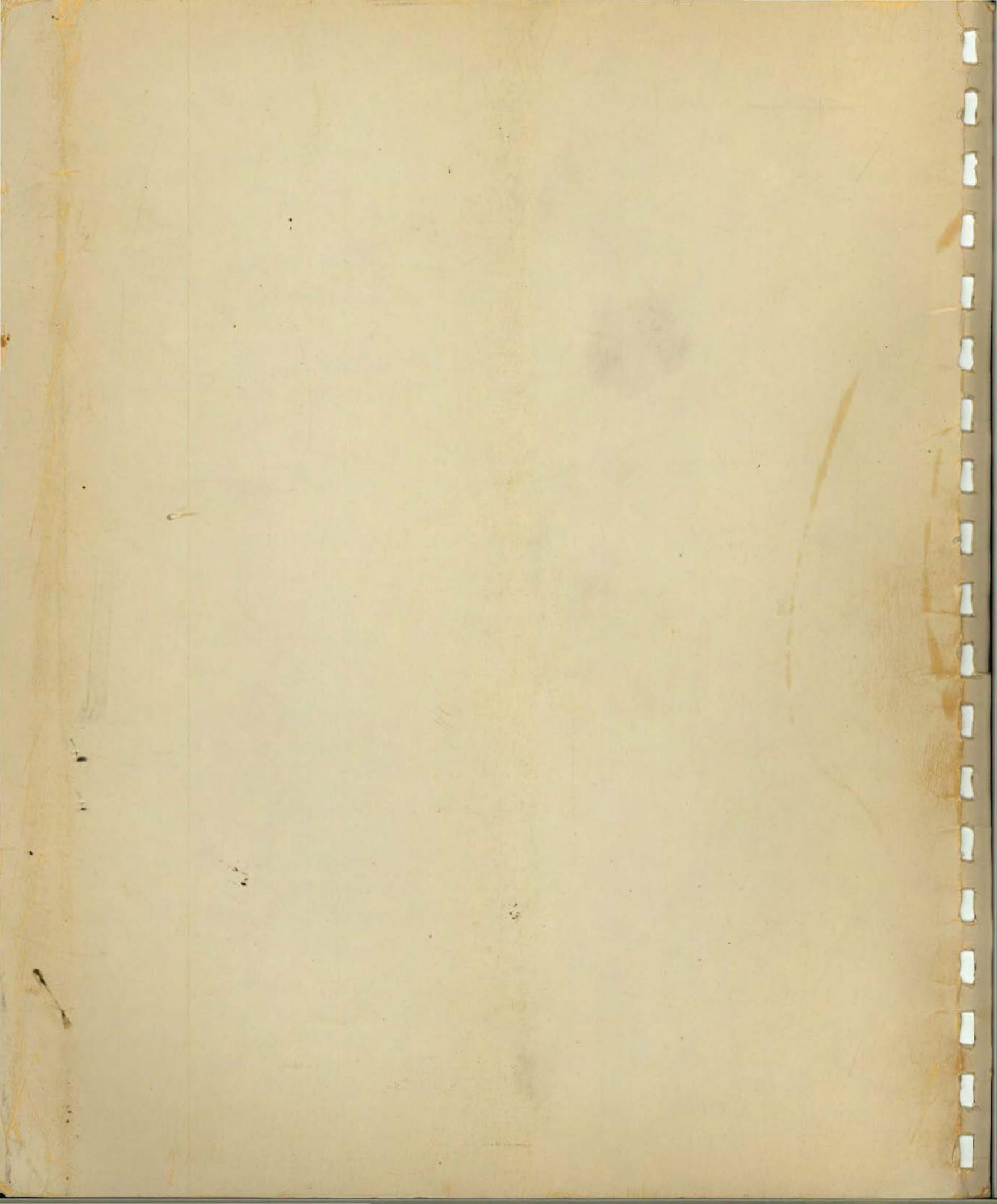


GL2020

Glenayre
electronics

Mobile
Telephone
Control Head
Instruction
Manual





GL2020
Radiotelephone Control Head

Instruction Manual

May 1982

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GLENAYRE ELECTRONICS.

Glenayre Part No. 176-0020

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Fig. 1 - GL2020 Radiotelephone Control Head

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Chapter 1

General Information

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Copilot 1

General Information

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1. GENERAL INFORMATION

Introduction

1.01 The GL 2020 radiotelephone control head (Fig.1) is a microprocessor based mobile telephone for use in IMTS, MTS, and 2805 Hz systems. The Unit features all electronics in one package, and has a universal interface to allow it to mate with virtually any radio.

Note: The Unit is not capable of operating automatically in areas using the Secode SMART system, or areas employing 2805 Hz signalling with a "marked busy" philosophy, except where those systems allow simple manual operation. (The Unit does, however, feature a 2805 Hz audio notch filter, for use in such systems).

Model Numbering and Ordering Information

1.02 The unit model number is broken down as shown in Table 1.

1.03 No other options need to be specified as the GL2020 is fully programmable for parameters such as channel designations, radio interface channel selection type etc..

Physical Configuration

1.04 The control head (Fig.1) features a "cellular" style plastic housing, with 18 standard telephone push buttons - rear illuminated with green LEDs (Light Emitting Diodes) for night operation, eight character

red LED alphanumeric display, four foot "pigtail" cable with optional 37D, ELCO or KS connector, die-cast swivel mount, built in loudspeaker, and all electronics in the one package. The handset with PTT (Push-To-Talk) switch is styled in the "K Series" fashion, with a plug-in modular cord.

Internal Configuration

1.05 The Unit comprises four main circuit modules:

- Keypad and Display Module
- MPU Module
- Power and Control Module
- Interface Module

These modules interconnect as depicted in Fig. 2.

1.06 The first three of the above modules are fastened to the front face plastic assembly. The Interface module fastens to the left hand plastic assembly, which includes the shallow speaker mounted underneath the module. The right hand plastic assembly forms the cradle for the handset.

1.07 The pigtail cable assembly plugs into the Interface module, and has a cable bushing for the strain relief cable clamp.

1.08 The handset features an "Electret" microphone insert for high quality audio. Its built-in preamplifier is powered from the carbon compatible mic bias supply. The handset connects to the Unit via a "modular" cord with telephone standard jacks on each end.

Model No.	Software Version	Cable Connector Option	Colour Option	Radio Interface Option
GL2020	A	37D	Black	04*
		ELCO	Beige	
		KS		
e.g. GL2020 - A - ELCO - Black - 04				

Table 1 - GL2020 Ordering Information

Notes: * "04" is the Universal Version for all radios. Other options are available on volume orders only - consult factory.

1.09 The swivel mount fastens via an adaptor bracket screwed to the plastic assembly.

1.10 Three trimming potentiometers - RX LEVEL, TX TONE, TX VOICE are accessed through holes in the plastic cover. Two rarely used VOL and SQUELCH pots are accessed by removing the cradle plastic (see Fig. 2).

Electronic Configuration

1.11 The electronic design features an 80C35 CMOS microprocessor with ROM (Read Only Memory) based software. All circuitry is solid state, except for the power and horn relays, and utilizes CMOS logic, thick film hybrid analog circuitry, and LED opto-electronics.

1.12 A CMOS RAM (Random Access Memory) memory stores all of the unit's "personality" attributes, such as telephone number identification's (ID's), radio interface type, feature attributes, and channel display

(Telco/RCC, VHF/UHF) characteristics. The RAM contents are maintained by the vehicle battery power when the Unit is switched off, and by an internal long life lithium battery should the vehicle battery be disconnected (or when the Unit is "on the shelf").

Software

1.13 The standard "A" software provides IMTS, MTS, and 2805 Hz signalling. The software incorporates all modern features, such as multi-area operation and repertory dialing, along with Glenayre's unique features of automatic dial tone detection, dual electronic locks, 20 pps IMTS dial (Mobile-to-Land) capability, call duration timer, independent speaker and earpiece push button volume adjustments, and many more. Careful human engineering allows the untrained user to operate the unit like any normal phone, while the sophisticated user can take advantage of the units' many convenience features.

installation

Chapter 2

Installation

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ELECTRICAL INSTALLATION	46

Chapter 2

Insist on

PAGE

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15	DETERMINING A MEAN
21	ORGANIZING DATA
26	DATA DISTRIBUTION
36	ELECTRICAL INSULATION

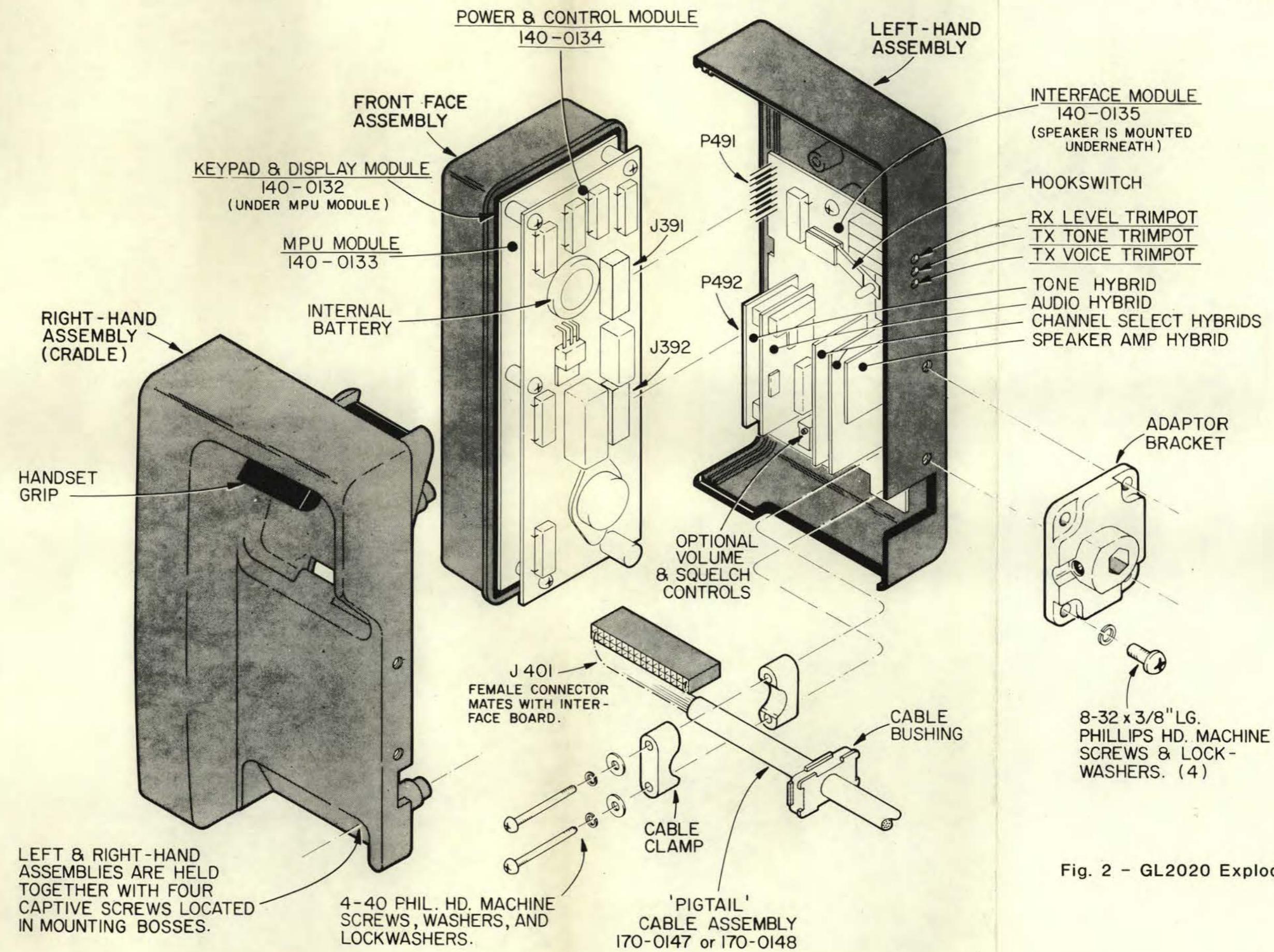
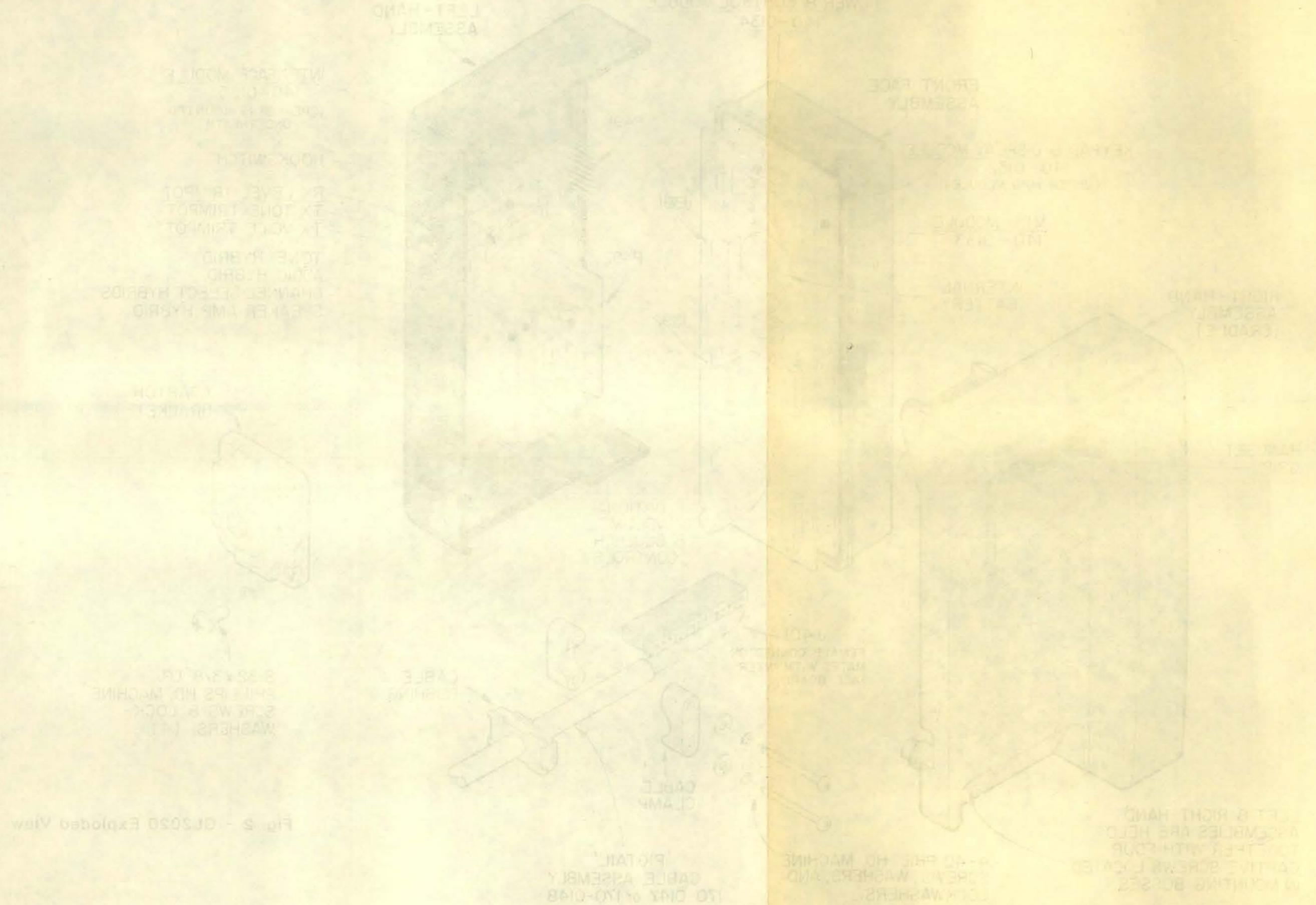


Fig. 2 - GL202 Exploded View

Fig. 5 - GRS-50 Exploded View



2. INSTALLATION

Introduction

2.01 This section provides instructions for the installation technician, as to the checkout, strapping, programming and installation of the GL2020 control head.

2.02 There is only one version of the Unit normally shipped - the "04" universal version. This version is "strapped" per radio interface drawing Fig. 5, and must be restrapped for other radios.

CHECKOUT AND STRAPPING

Preliminary Checks

2.03 Visually check for shipping damage. If any damage is apparent notify Glenayre and the carrier immediately.

2.04 Check that the control head color and "pigtail" connector type are as ordered, per paragraph 1.02.

Control Head Strapping

2.05 Universal Models ("04") require opening in order to check and possibly correct the internal strapping options.

2.06 Open the Unit as follows, referring to Fig. 2:

***** CAUTION *****

Control head utilizes thick film hybrids. Harsh mechanical treatment may damage the circuitry. Exercise caution when removing the cradle plastic.

- (a) Remove the two screws, holding the swivel mount bracket to the control head plastic case, on the cradle side.
- (b) Remove the four screws holding the cradle plastic in place.
- (c) Carefully remove the cradle plastic, revealing the Interface module.

2.07 Refer to the appropriate Radio Interface Drawing, as listed in Table 2, for information on the following items:

- (a) jumper options
- (b) radio modifications
- (c) cable modifications

Radio Type	Fig. No.	Page No.
GE Exec II (IMTS & RCC)	Fig.4	Page 7
Aerotron 600/800TT	Fig.5	Page 9
Standard 809DTR	Fig.6	Page 11
Harris - 1500, 1525, 1555, 450, 455, 4500	Fig.7	Page 13
Harris - 150, 155, (Series 400)	Fig.8	Page 15
Harris - Alpha 2000 Series	Fig.9	Page 17
GE "KS" ET67, ER45	Fig.10	Page 19
Motorola - T1200, 1400, 1600, 1800	Fig.11	Page 21
NEC TR4E16-2A (UHF)	Fig.12	Page 23
	Fig.13	Page 25
	Fig.14	Page 27
	Fig.15	Page 29
	Fig.16	Page 31
	Fig.17	Page 33
	Fig.18	Page 35
	Fig.19	Page 37

Table 2 - Radio Interface Drawings

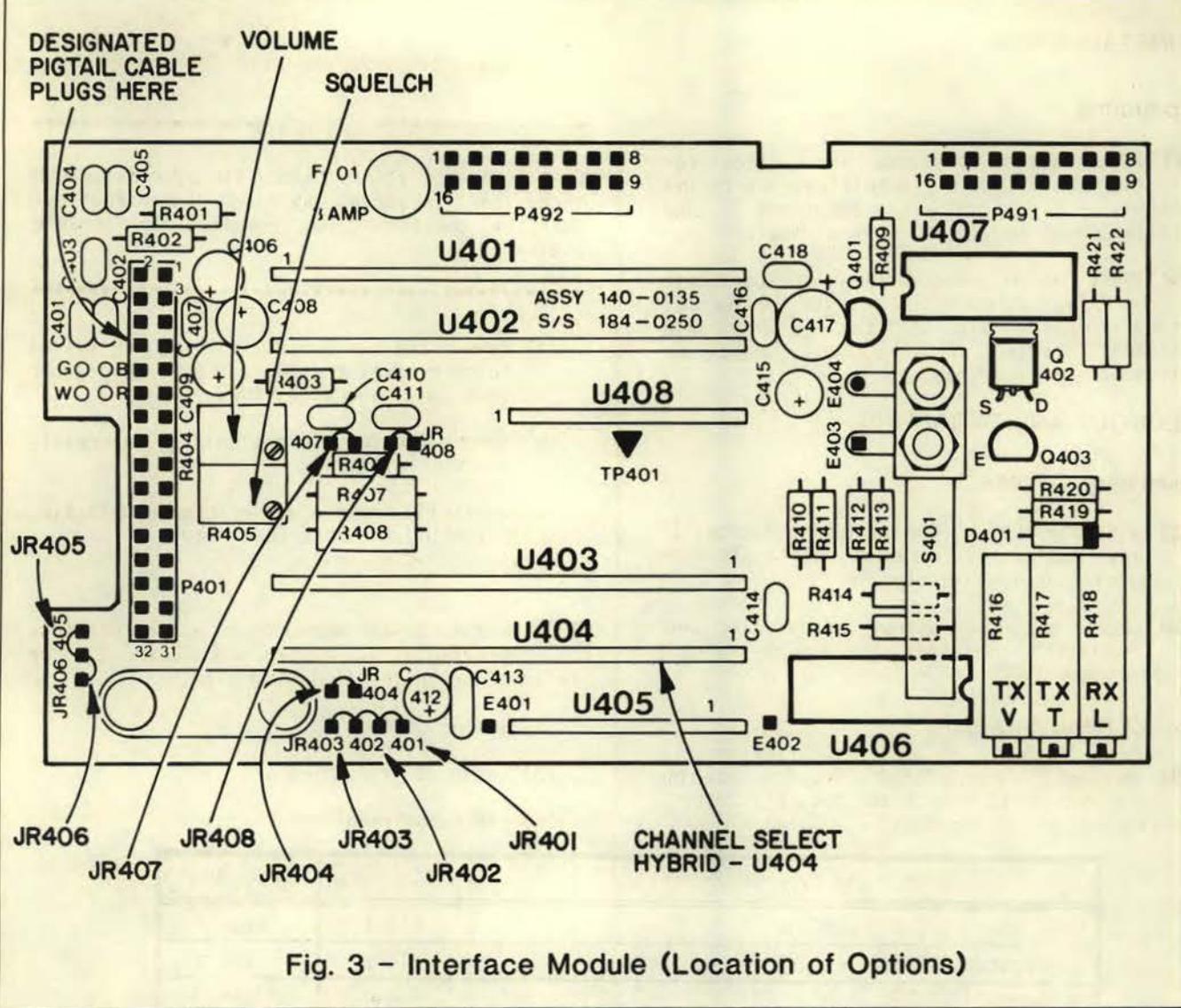


Fig. 3 – Interface Module (Location of Options)

Modify the control head per the information supplied.

Note: If the radio is non-standard i.e. not listed in Table 2, refer to Appendix B for correct strapping and modifications.

2.08 Fig.3 shows the location of jumper options on the Interface module for the various radio types.

2.09 Replace the cradle plastic and screws, being careful not to "pinch" the pigtail cable harness and to ensure the handset modular connector remains securely in place.

Bench Check

2.10 The Unit should ideally be set up with the final radio on the bench, prior to vehicle installation.

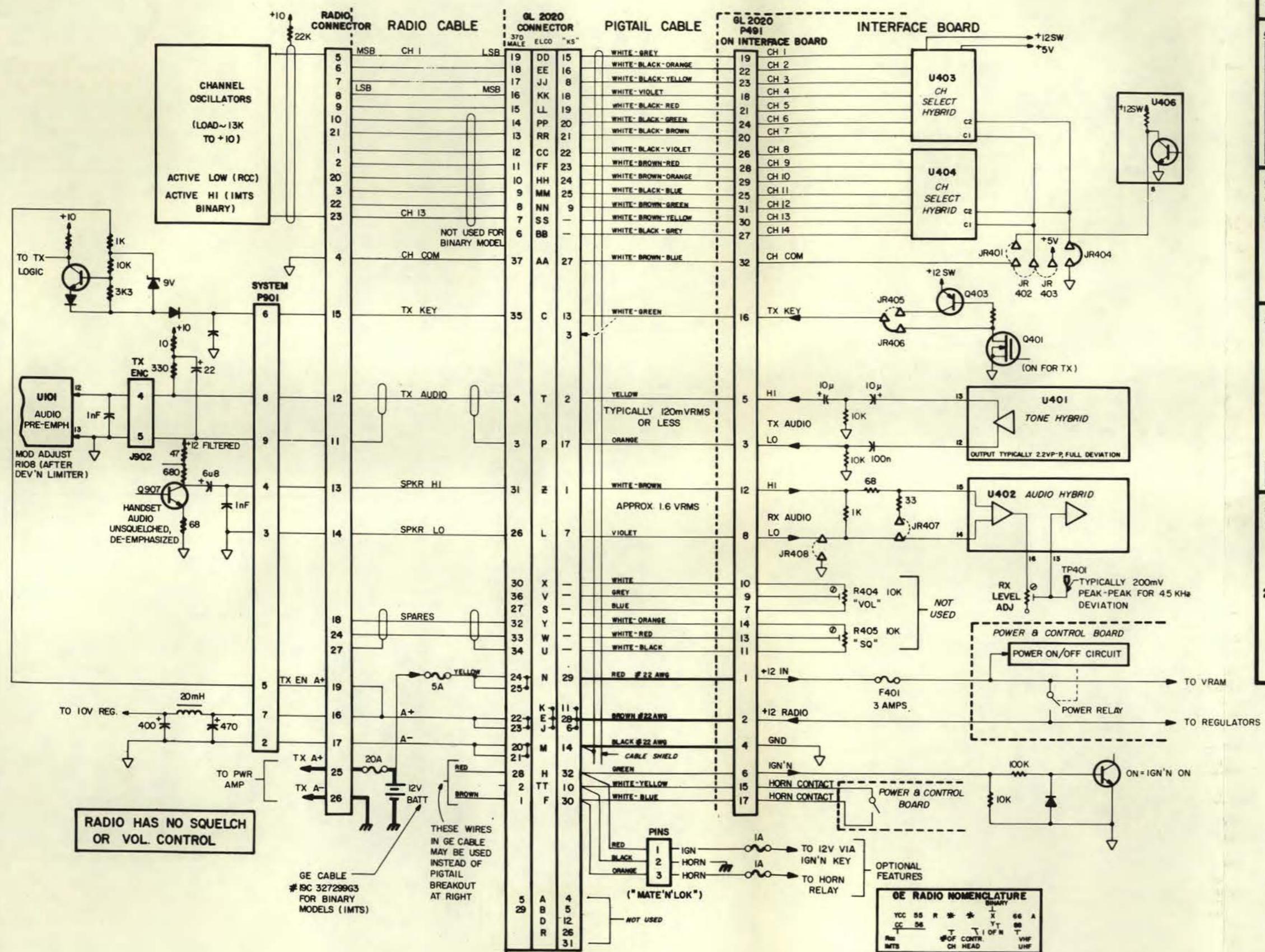
2.11 Connect a dummy load to the antenna, plug in the control head cable and power cable to the radio, plug in the control head, and switch on. (TOUCH [ON]).

2.12 If the Unit indicates a flashing [SERVICE] message, it needs programming.

***** CAUTION *****

If a Unit needs programming it may come on with the transmitter on. Turn the Unit off or enter the technician mode immediately.

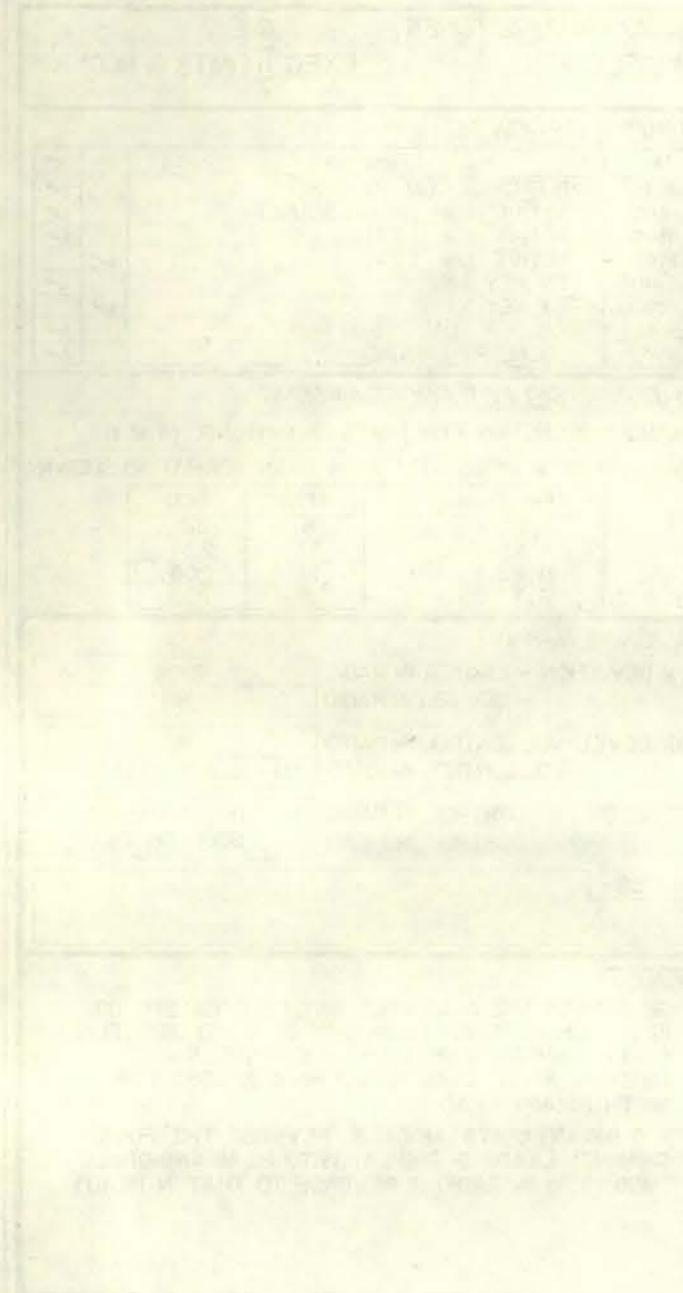
2.13 If the Unit appears "dead" - it may be locked! Refer to paragraph 3.25 for unlocking procedures or enter the technician mode.



RADIO MANUFACTURER: G.E.
MODEL(S): EXEC II (IMTS & RCC)

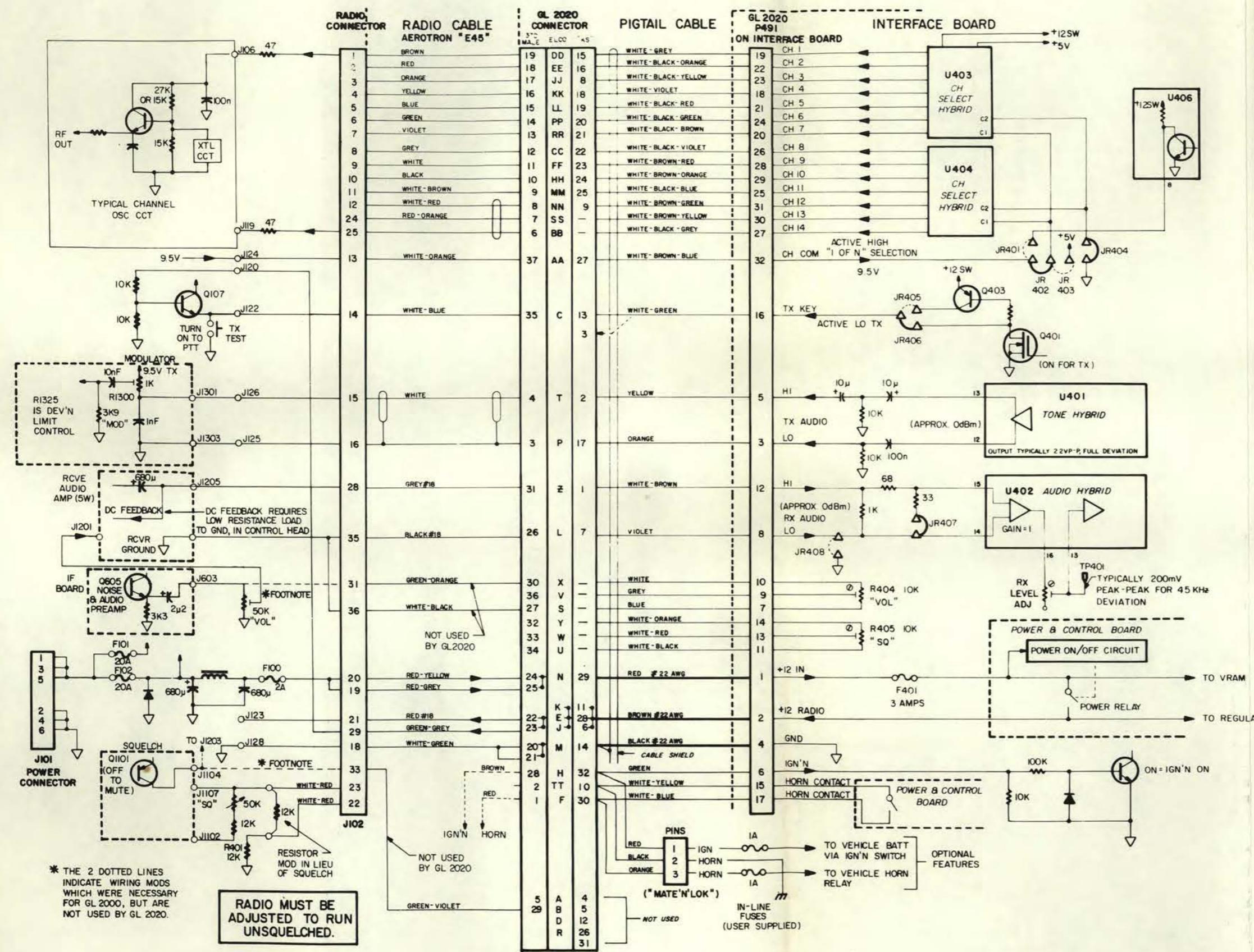
JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO		✓
JR402	ACTIVE HIGH (RADIO SOURCE)		✓
JR403	ACTIVE HIGH (5V)		✓
JR404	ACTIVE LOW (0V)		✓
JR405	TX KEY HIGH		✓
JR406	TX KEY LOW		✓
JR407	100 Ohm LOAD 9 dB PAD		✓
JR408	LOCAL RX GROUND		✓



Primary mission area
TODAY'S DATE

180 - 0079 - A



RADIO MANUFACTURER: AEROTRON
MODEL(S): 600/800 TT

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO		✓
JR402	ACTIVE HIGH (RADIO SOURCE)	✓	
JR403	ACTIVE HIGH (5V)		✓
JR404	ACTIVE LOW (0V)	✓	
JR405	TX KEY HIGH		✓
JR406	TX KEY LOW	✓	
JR407	100 Ohm LOAD 9 dB PAD		✓
JR408	LOCAL RX GROUND		✓

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE ACTIVE HIGH 1 OF N

PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	128
1,3,5,7,---	160
21,22,23,---	144
31,32,33,---	136

ALIGNMENT:

TX DEVIATION - LIMITER IN RADIO R I325
- DEV. ADJ. IN RADIO R I300

RX LEVEL -VOL. CONTROL IN RADIO YES
-VOL. CONTROL IN HEAD NO

SQUELCH --- CONTROL IN RADIO YES
--- CONTROL IN HEAD NO

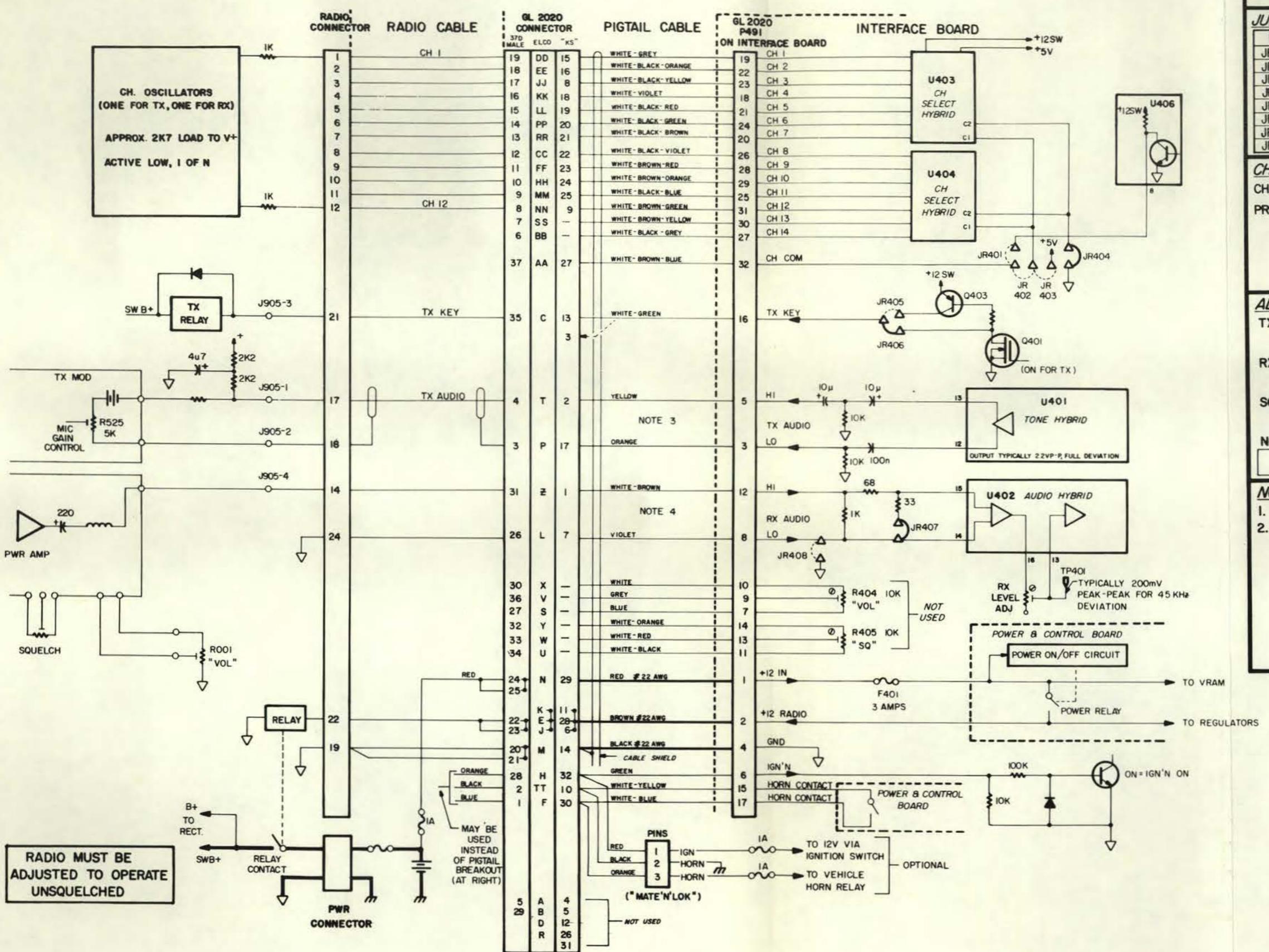
NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

1. ADJUST RADIO TO OPERATE UNSQUELCHED.
 2. AEROTRON E45 CABLE USES 37D CONNECTOR.
 3. AEROTRON E33 CABLE USES ELCO CONNECTOR.
 4. CHECK CABLE WIRING IF USING 12, 13, or 14 CHANNELS.

**Fig. 5 – Radio Interface Drawing
(Aerotron 600/800TT)**

180-0081-A



RADIO MANUFACTURER: STANDARD
MODEL(S): 809/859 DTR

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO		✓
JR402	ACTIVE HIGH (RADIO SOURCE)		✓
JR403	ACTIVE HIGH (5V)		✓
JR404	ACTIVE LOW (OV)	✓	
JR405	TX KEY HIGH		✓
JR406	TX KEY LOW	✓	
JR407	100 Ohm LOAD 9 dB PAD	✓	
JR408	LOCAL RX GROUND		✓

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE ACTIVE LO, 1 OF N

PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	192
1,3,5,7,---	224
21,22,23,---	208
31,32,33,---	200

ALIGNMENT:

TX DEVIATION - LIMITER IN RADIO
- DEV. ADJ. IN RADIO YES
R525

RX LEVEL -VOL CONTROL IN RADIO
-VOL CONTROL IN HEAD

SQUELCH --- CONTROL IN RADIO YES
--- CONTROL IN HEAD NO

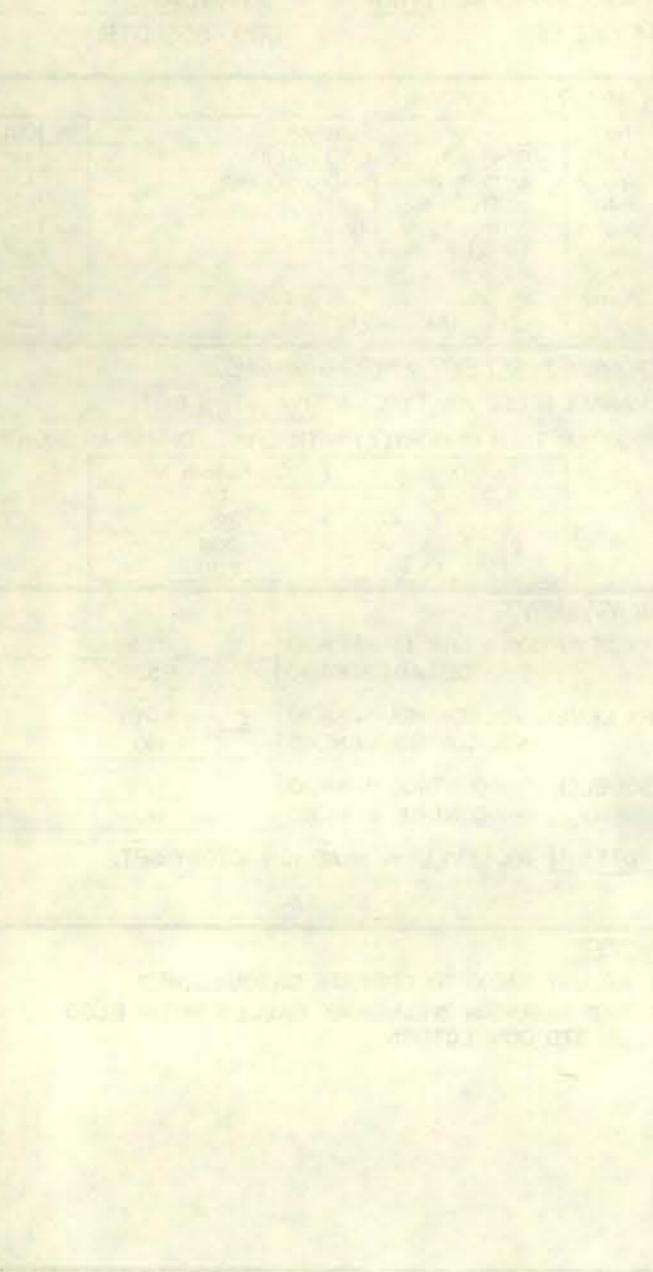
NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

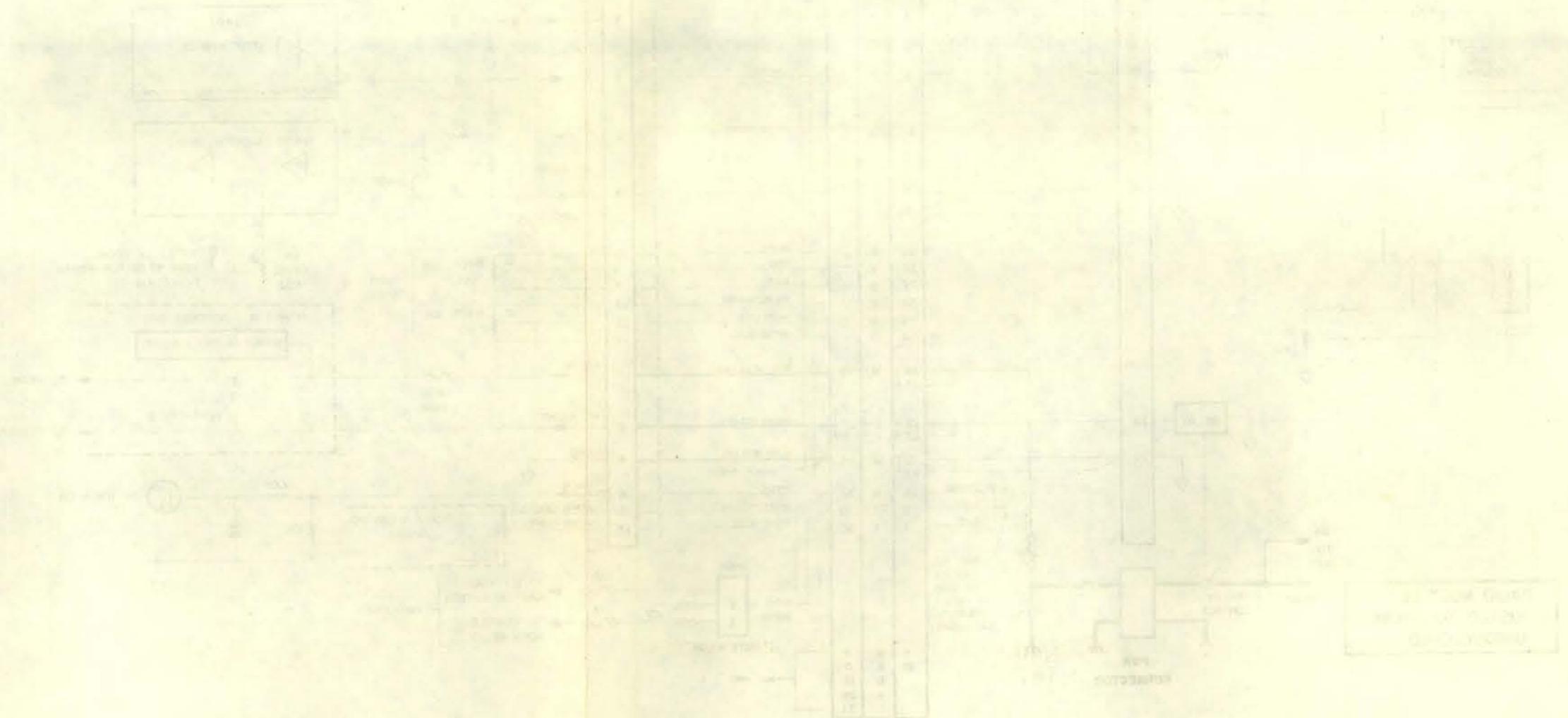
1. ADJUST RADIO TO OPERATE UNSQUELCHED.
 2. USE REGULAR 'STANDARD' CABLES WITH ELCO OR 37D CONNECTORS.

**Fig. 6 – Radio Interface Drawing
(Standard 809 DTR)**

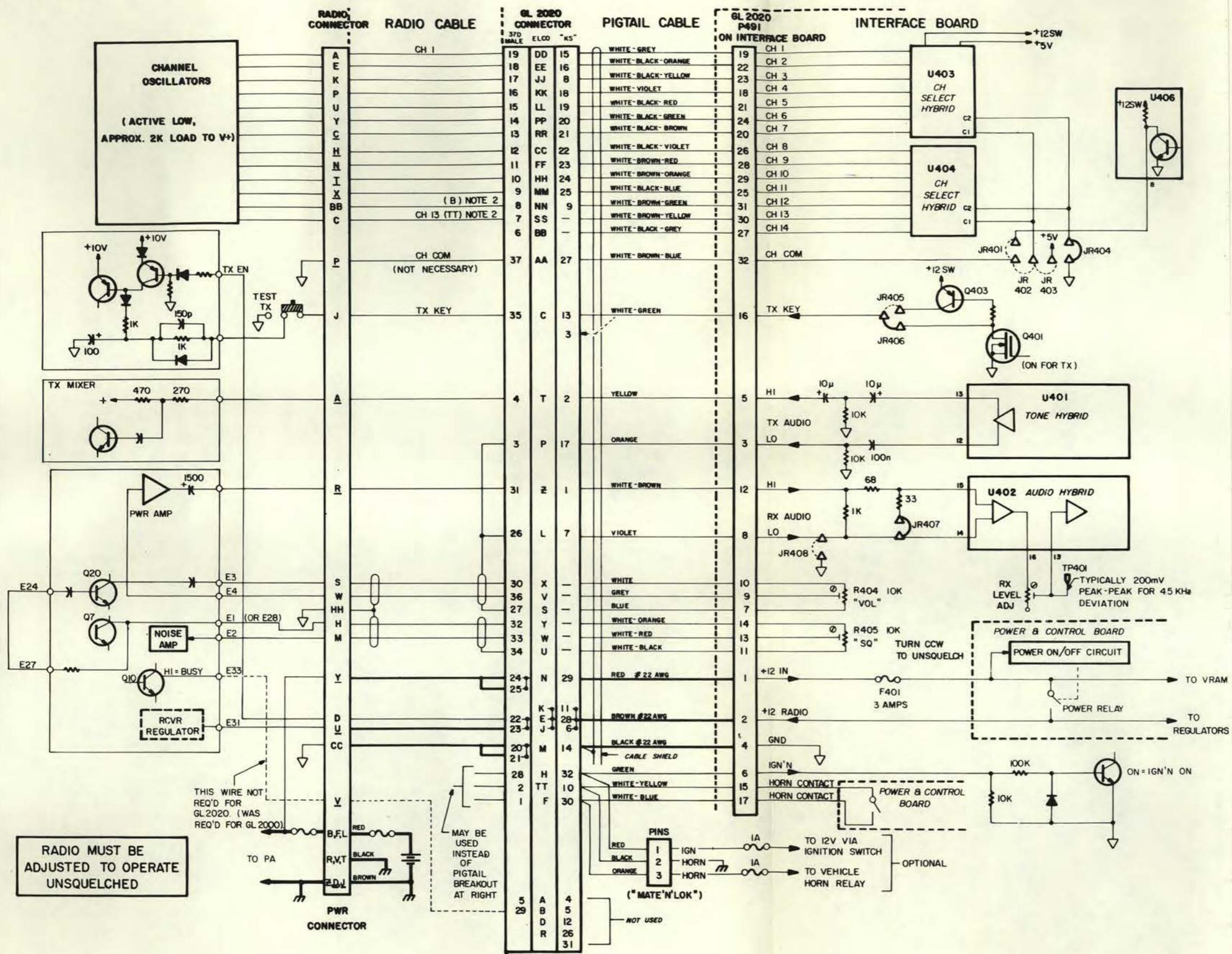
001-000-000000000000



Page 111
001-000-000000000000
(B)anding 800 QTR



180-0082-A



RADIO MANUFACTURER: HARRIS		
MODEL(S): 1500, 1525, 1555, 450, 455, & 4500		
JUMPER OPTIONS:		
No.	Function	In Out
JR401	FOR CHAN. COM. TO RADIO	✓
JR402	ACTIVE HIGH (RADIO SOURCE)	✓
JR403	ACTIVE HIGH (5V)	✓
JR404	ACTIVE LOW (OV)	✓
JR405	TX KEY HIGH	✓
JR406	TX KEY LOW	✓
JR407	100 Ohm LOAD 9 dB PAD	✓
JR408	LOCAL RX GROUND	✓

CHANNEL SELECT PROGRAMMING:	
CHANNEL SELECTION TYPE	ACTIVE LO, 1 OF N
PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN	
For Display	Ch. Format No.
1,2,3,4,---	192
1,3,5,7,---	224
21,22,23,---	208
31,32,33,---	200

ALIGNMENT:	
TX DEVIATION - LIMITER IN RADIO	CONSULT RADIO MANUAL
- DEV. ADJ. IN RADIO	
RX LEVEL - VOL. CONTROL IN RADIO	NO
- VOL. CONTROL IN HEAD	R404
SQUELCH --- CONTROL IN RADIO	NO
--- CONTROL IN HEAD	R405

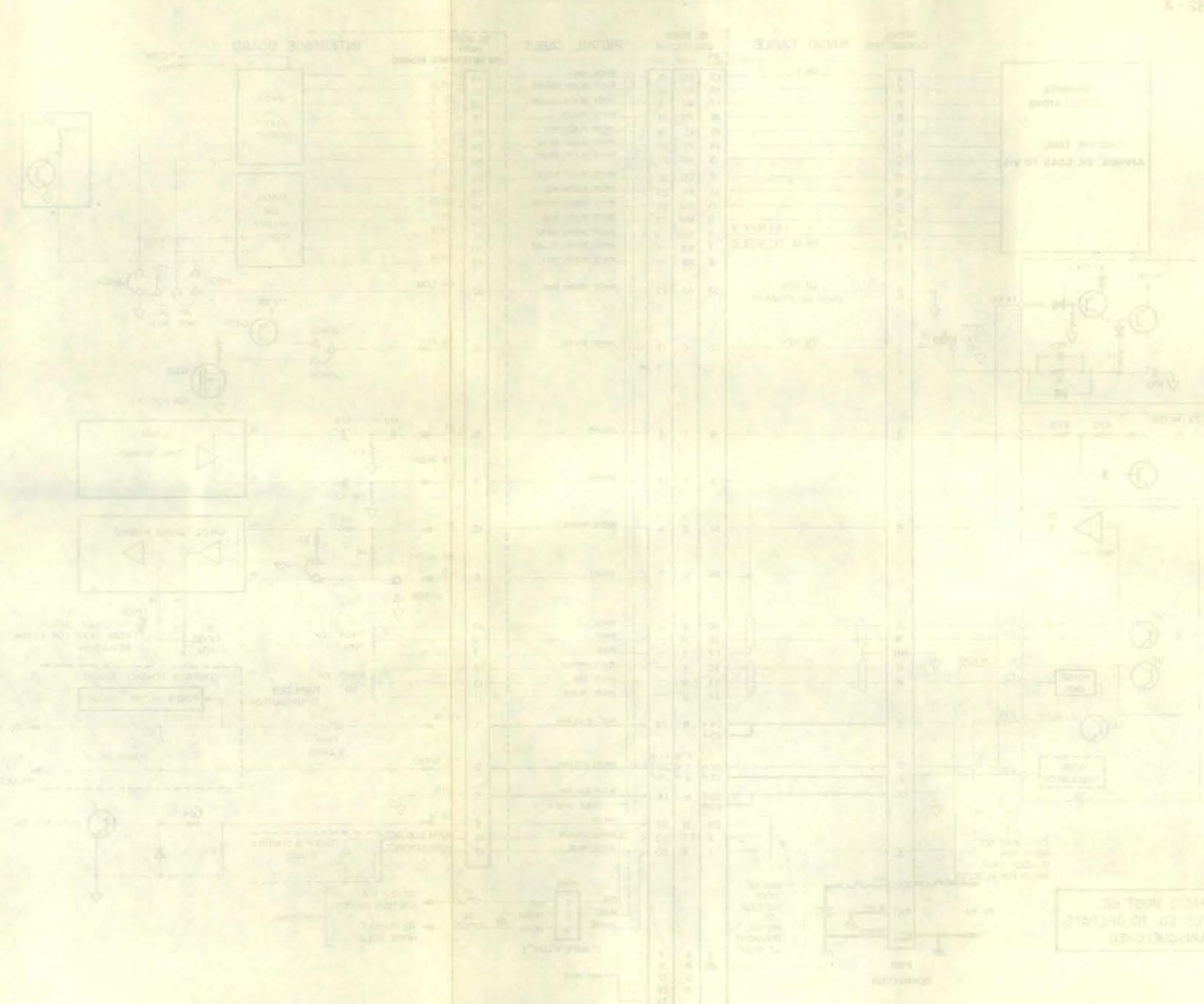
NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

- NOTES:**
1. ADJUST RADIO TO OPERATE UNSQUELCHED.
 2. THE REGULAR HARRIS CABLE FOR THE RF495 HEAD HAS AN ELCO CONNECTOR AND IS PLUG COMPATIBLE. CHECK WIRES FOR CHANNELS 12 & 13, AS THE PIN NUMBERS USED VARY WITH DIFFERENT VINTAGES OF HARRIS CABLE. (DO NOT CHECK IF 11 OR FEWER CHANS.)
 3. RADIO CIRCUITRY SHOWN IS CT1555. OTHER MODELS USE SAME CONNECTOR, CABLE, & INTERFACE.
 4. CONTROL HEAD STRAPPING & PROGRAMMING IS SAME AS THAT FOR HARRIS 150/155 SERIES.

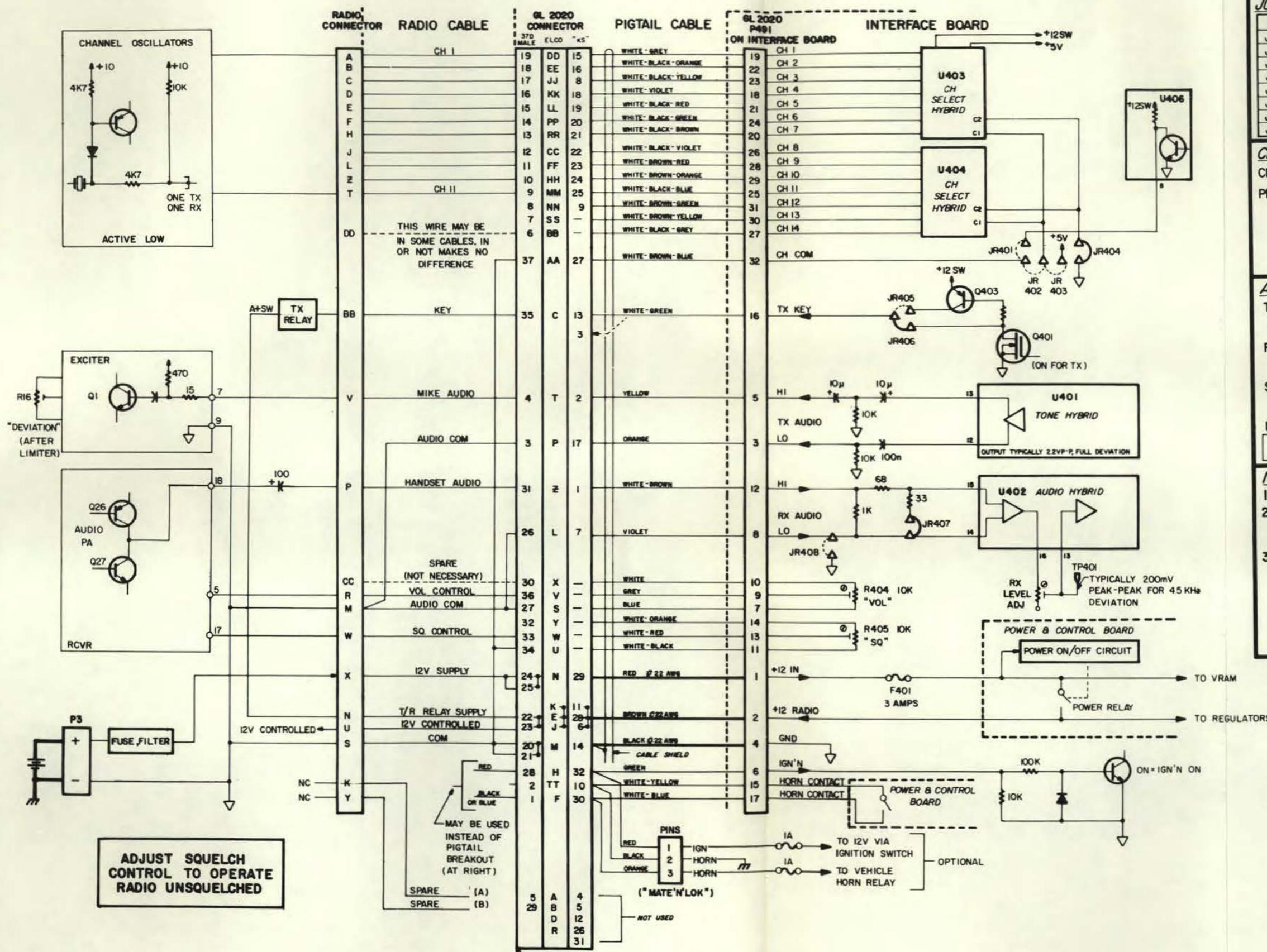
Fig. 7 – Radio Interface Drawing
(Harris 1500/1525/1555/450/455/4500)

WIRELESS COMMUNICATIONS	
WIRELESS COMMUNICATIONS	
100-000-000-100	100-000-000-100
100-000-000-100	100-000-000-100
100-000-000-100	100-000-000-100

Figure 3 - Radio Interface Diagram
(Model 100-000-000-100)



180-0083-A



RADIO MANUFACTURER: HARRIS
MODEL(S): 150/155/(SERIES 400)

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN COM. TO RADIO		✓
JR402	ACTIVE HIGH (RADIO SOURCE)		✓
JR403	ACTIVE HIGH (5V)		✓
JR404	ACTIVE LOW (OV)		✓
JR405	TX KEY HIGH		✓
JR406	TX KEY LOW		✓
JR407	100 Ohm LOAD 9 dB PAD		✓
JR408	LOCAL RX GROUND		✓

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE ACTIVE LO, 1 OF N

PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	192
1,3,5,7,---	224
21,22,23,---	208
31,32,33,---	200

ALIGNMENT:

TX DEVIATION - LIMITER IN RADIO	R 16
- DEV. ADJ. IN RADIO	NO
RX LEVEL-VOL CONTROL IN RADIO	NO
- VOL. CONTROL IN HEAD	R404
SQUELCH --- CONTROL IN RADIO	NO
--- CONTROL IN HEAD	R405

NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

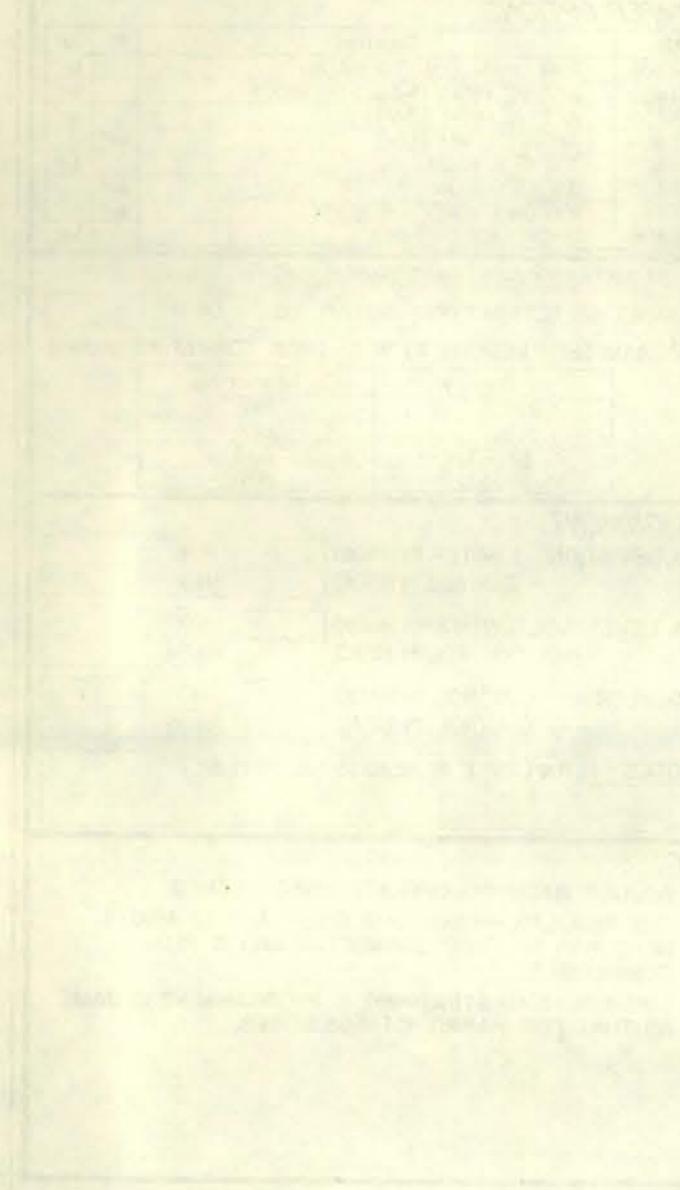
1. ADJUST RADIO TO OPERATE UNSQUELCHED.
2. THE REGULAR HARRIS CABLE FOR THE RF 4910/II HEAD HAS AN ELCO CONNECTOR AND IS PLUG COMPATIBLE.
3. CONTROL HEAD STRAPPING & PROGRAMMING IS SAME AS THAT FOR HARRIS CT 1555 SERIES.

Fig. 8 - Radio Interface Drawing (Harris 150/155/Series 400)

1001-000-000-000-1.psd

A-0000-000

1001-000-000-000-1.psd
A-0000-000



1001-000-000-000-1.psd
A-0000-000

1001-000-000-000-1.psd

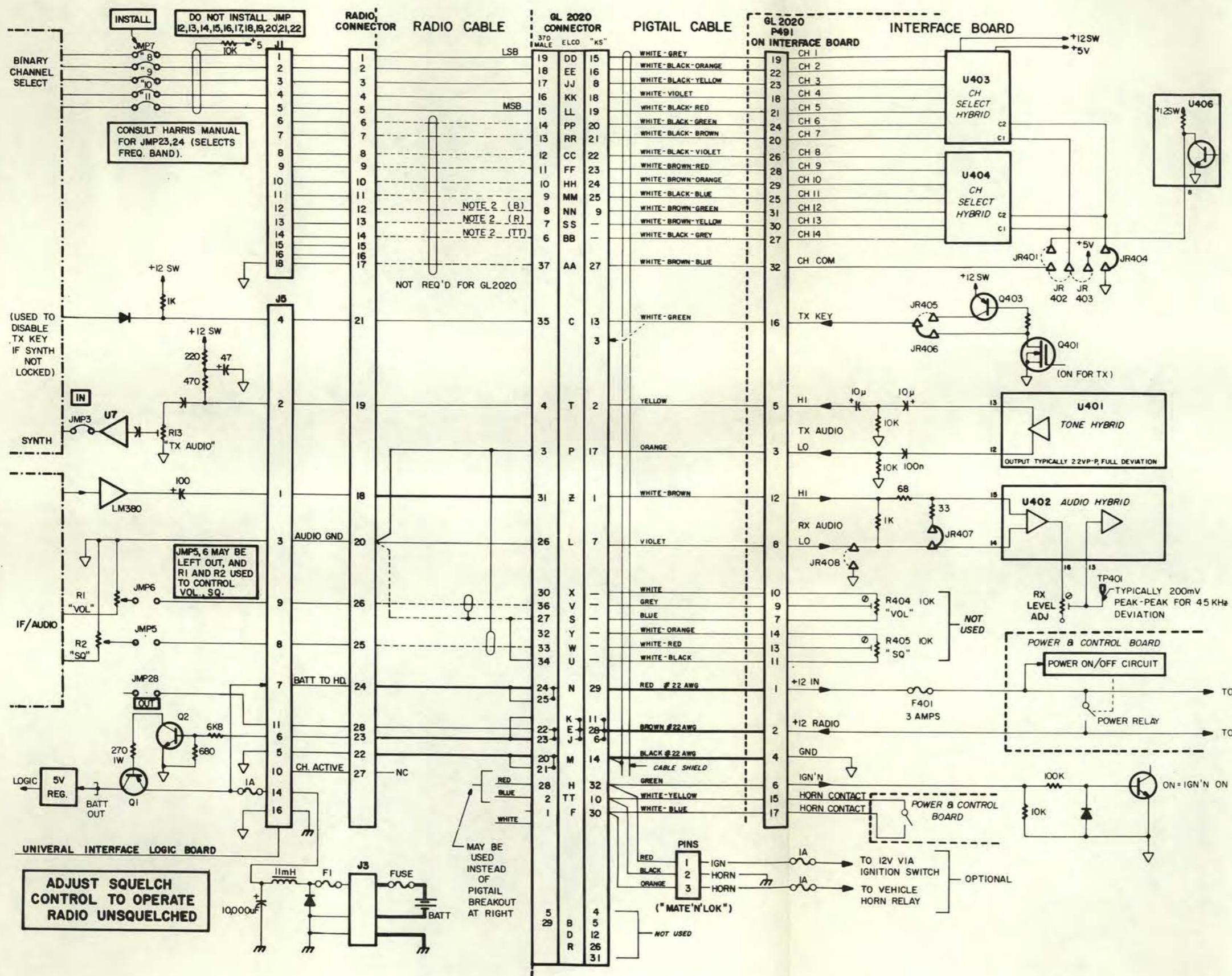
1001-000-000-000-1.psd

1001-000-000-000-1.psd

1001-000-000-000-1.psd
A-0000-000

1001-000-000-000-1.psd

180-0084-A



RADIO MANUFACTURER: HARRIS
MODEL(S): ALPHA 2000 SERIES

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO		✓
JR402	ACTIVE HIGH (RADIO SOURCE)		✓
JR403	ACTIVE HIGH (5V)		✓
JR404	ACTIVE LOW (OV)	✓	
JR405	TX KEY HIGH		✓
JR406	TX KEY LOW	✓	
JR407	100 Ohm LOAD 9 dB PAD	✓	
JR408	LOCAL RX GROUND		✓

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE BINARY ACTIVE HI
PROGRAM TECH MEMORY(7) WITH CHAN FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	5
1,3,5,7,---	37
21,22,23,---	21
31,32,33,---	13

ALIGNMENT:

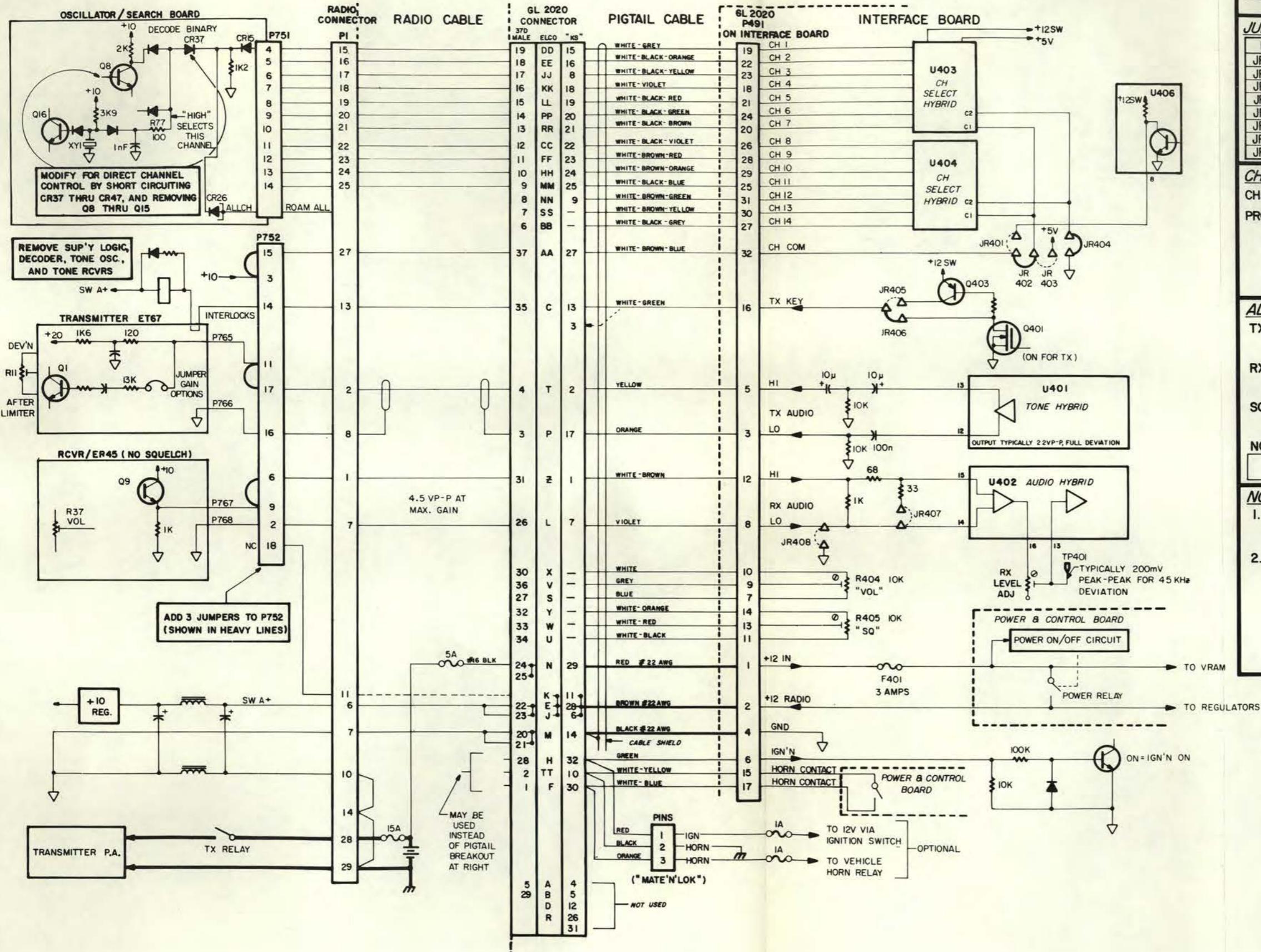
TX DEVIATION - LIMITER IN RADIO	YES
- DEV. ADJ. IN RADIO	R13
RX LEVEL - VOL. CONTROL IN RADIO	R1
- VOL. CONTROL IN HEAD	NO
SQUELCH --- CONTROL IN RADIO	R2
--- CONTROL IN HEAD	NO

NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

1. ADJUST RADIO TO OPERATE UNSQUELCHED.
 2. RADIO CABLE SHOWN IS 'ELCO' STD. 10029-0898 FOR HARRIS & SECODE HEADS. INCONSISTENCIES IN ELCO PIN NO'S. OF CH. I2, I3, & I4 LINES DO NOT MATTER SINCE ONLY 5(BINARY) CHANNEL LINES ARE USED.
 3. CONTROL HEAD STRAPPING IS THE SAME AS FOR ALL OTHER HARRIS RADIOS.
 4. ENSURE RADIO INTERFACE BOARD IS STRAPPED AS SHOWN

**Fig. 9 – Radio Interface Drawing
(Harris Alpha 2000 Series)**



RADIO MANUFACTURER: G.E.
MODEL(S): KS (ET67,ER45)

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO	✓	
JR402	ACTIVE HIGH (RADIO SOURCE)	✓	
JR403	ACTIVE HIGH (5V)	✓	
JR404	ACTIVE LOW (OV)	✓	
JR405	TX KEY HIGH		
JR406	TX KEY LOW	✓	
JR407	100 Ohm LOAD 9 dB PAD	✓	
JR408	LOCAL RX GROUND	✓	

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE ACTIVE HI, 1 OF N
PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	I28
1,3,5,7,---	I60
21,22,23,---	I44
31,32,33,---	I36

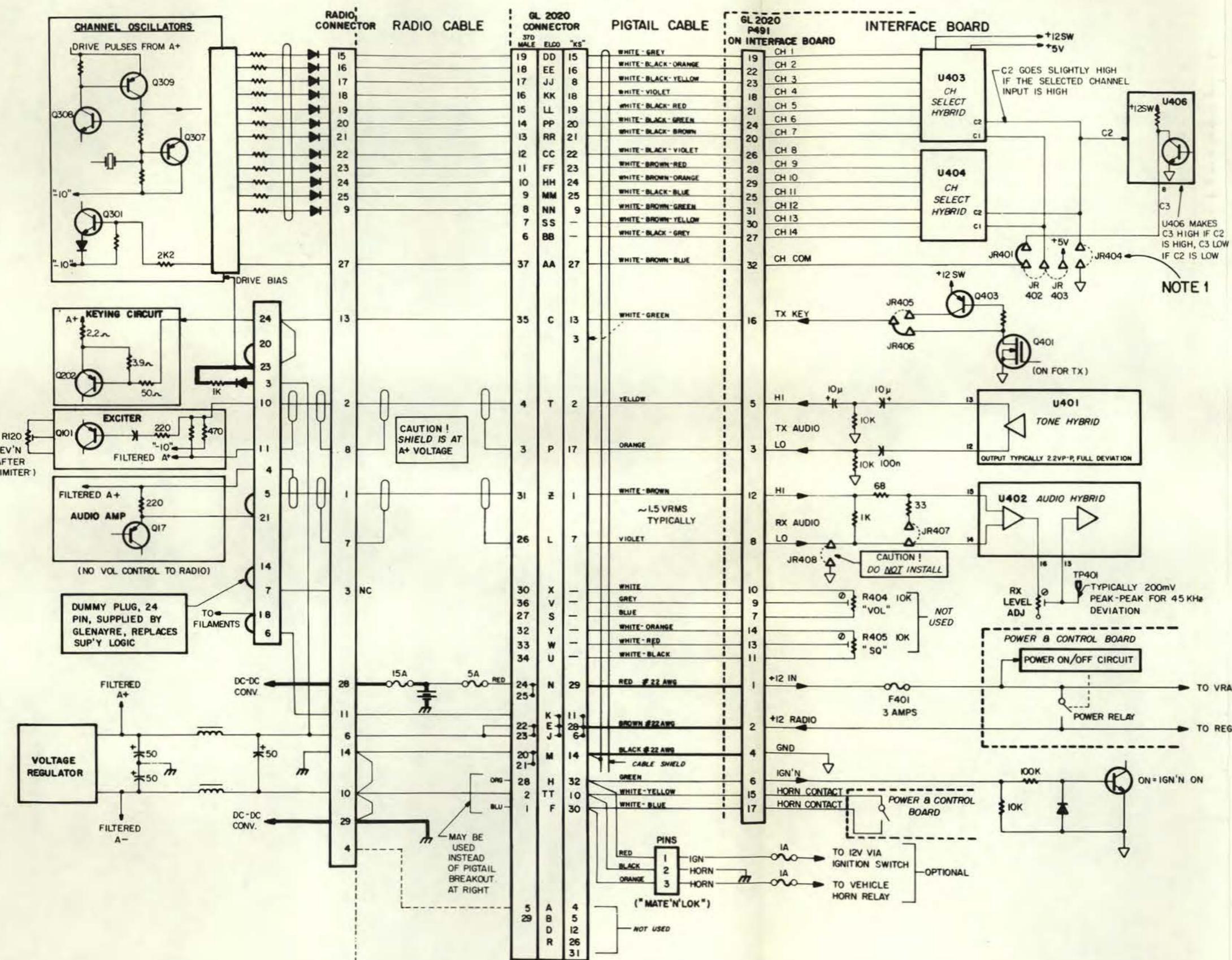
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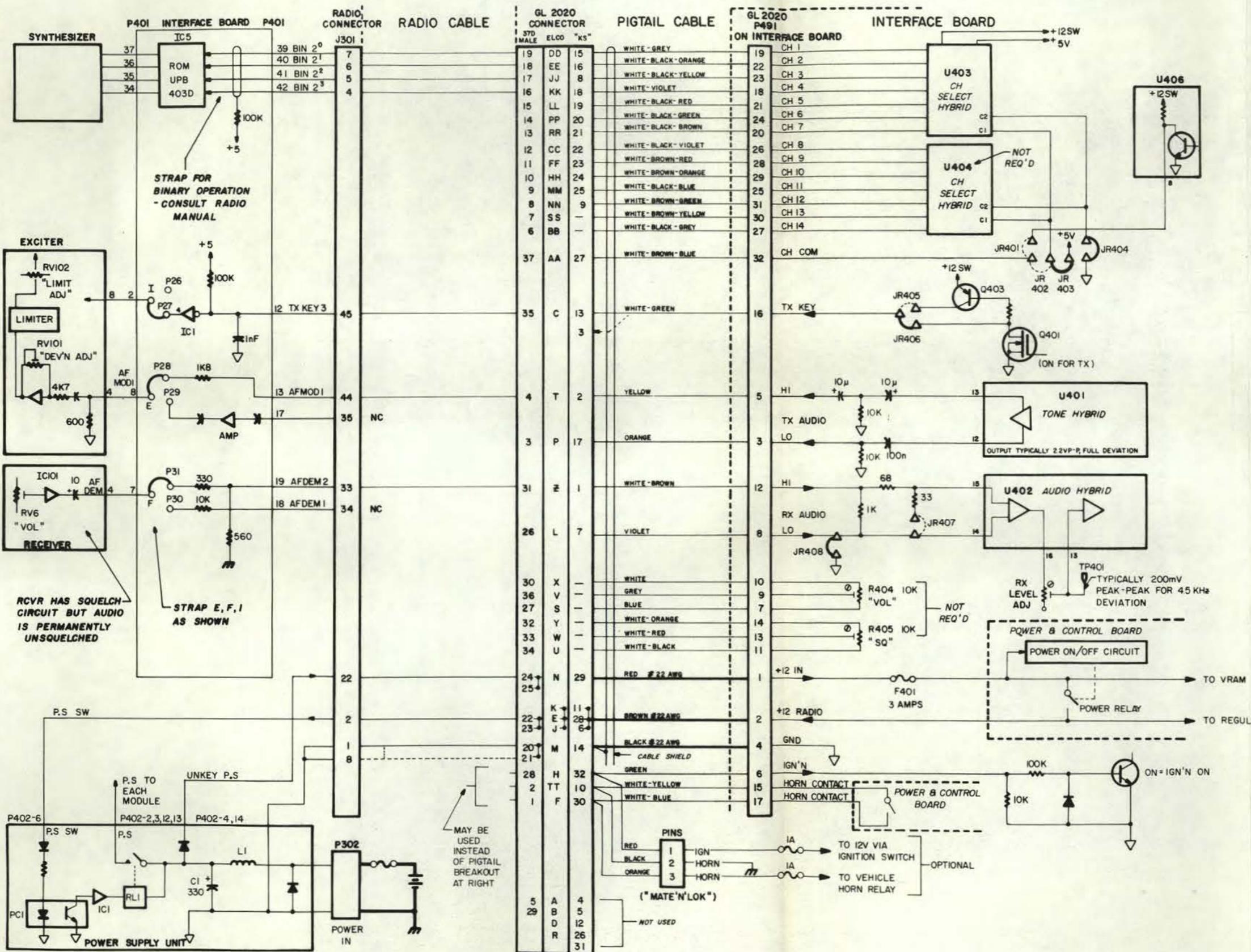
TX DEVIATION - LIMITER IN RADIO R II
- DEV. ADJ. IN RADIO NO
RX LEVEL-VOL. CONTROL IN RADIO R37
- VOL. CONTROL IN HEAD NO
SQUELCH --- CONTROL IN RADIO NO - RADIO HAS NO SQUELCH CCT.
NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

- CAUTION! RADIO MUST BE MODIFIED AS SHOWN. CONSULT APPLICATION NOTES FOR MORE DETAILS. THIS MOD. IS THE SAME AS WAS USED FOR 'GL2000'.
- STANDARD 'KS' CABLE IS PLUG COMPATIBLE.

Fig. 10 – Radio Interface Drawing (GE "KS" ET67,ER45)





RADIO MANUFACTURER: NEC
MODEL(S): TR4E16-2A (UHF)

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO	✓	
JR402	ACTIVE HIGH (RADIO SOURCE)	✓	
JR403	ACTIVE HIGH (5V)	✓	
JR404	ACTIVE LOW (OV)	✓	
JR405	TX KEY HIGH	✓	
JR406	TX KEY LOW	✓	
JR407	100 Ohm LOAD 9 dB PAD	✓	
JR408	LOCAL RX GROUND	✓	

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE	
ACTIVE HI	BINARY
PROGRAM TECH	MEMORY(7) WITH CHAN. FORMAT AS SHOWN
For Display	Ch. Format No.
1,2,3,4,---	5
1,3,5,7,---	37
21,22,23,---	21
31,32,33,---	13

ALIGNMENT:

TX DEVIATION - LIMITER IN RADIO	RV102
- DEV. ADJ. IN RADIO	RV101
RX LEVEL - VOL CONTROL IN RADIO	RV6
- VOL CONTROL IN HEAD	NO
SQUELCH --- CONTROL IN RADIO	YES - BUT NOT USED
--- CONTROL IN HEAD	NO

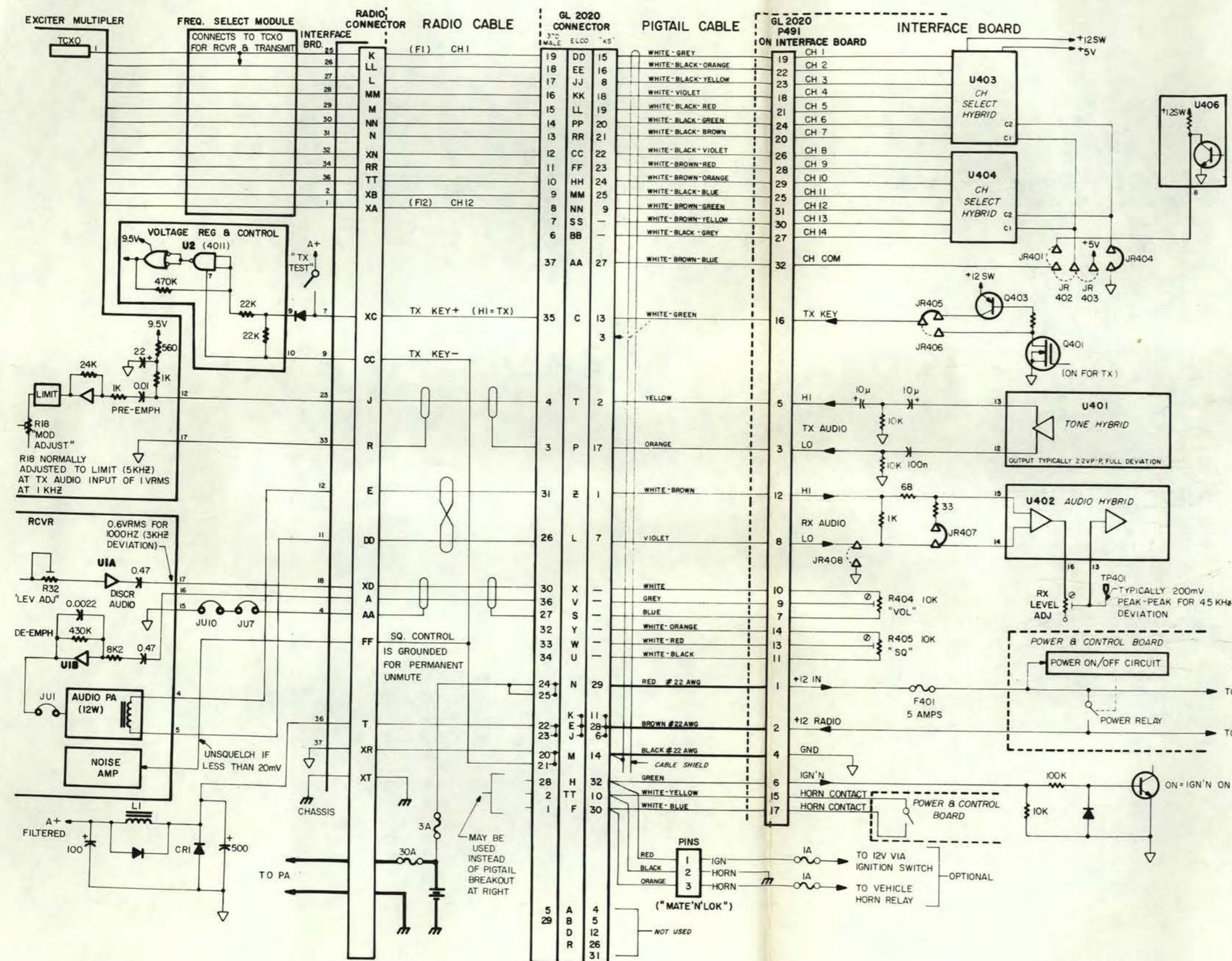
NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

1. ADJUST RADIO TO OPERATE UNSQUELCHED.
2. STRAP RADIO INTERFACE BOARD AS SHOWN.
3. RADIO CABLE IS WIRED AS PER DRAWING AND CONNECTOR IS PROBABLY ELCO. CHANNEL SELECT WIRES MUST BE AS SHOWN UNLESS CABLE IS FOR OTHER TYPE OF HEAD, IN WHICH CASE WIRES MUST BE CHECKED.

Fig. 12 – Radio Interface Drawing
NEC TR4E16-2A (UHF)

180-0090-A



RADIO MANUFACTURER: RCA
MODEL(S): VEETAC

JUMPER OPTIONS:

No.	Function	In	Out
JR401	FOR CHAN. COM. TO RADIO	✓	✓
JR402	ACTIVE HIGH (RADIO SOURCE)	✓	✓
JR403	ACTIVE HIGH (5V)	✓	✓
JR404	ACTIVE LOW (OV)	✓	✓
JR405	TX KEY HIGH	✓	✓
JR406	TX KEY LOW	✓	✓
JR407	100 Ohm LOAD 9 dB PAD	✓	✓
JR408	LOCAL RX GROUND	✓	✓

CHANNEL SELECT PROGRAMMING:

CHANNEL SELECTION TYPE ACTIVE LO, 1 OF N

PROGRAM TECH MEMORY(7) WITH CHAN. FORMAT AS SHOWN

For Display	Ch. Format No.
1,2,3,4,---	192
1,3,5,7,---	224
21,22,23,---	208
31,32,33,---	200

ALIGNMENT:

TX DEVIATION - LIMITER IN RADIO	R18
- DEV. ADJ. IN RADIO	NO
RX LEVEL-VOL CONTROL IN RADIO	R32 (FACTORY SET)
- VOL CONTROL IN HEAD	R404
SQUELCH --- CONTROL IN RADIO	NO
--- CONTROL IN HEAD	NO

NOTES - 'RX LEVEL' IN HEAD IS FACTORY SET.

NOTES:

1. RADIO OPERATES PERMANENTLY UNSQUELCHED. ENSURE RADIO IS DUPLEX.
2. NO REGULAR RCA CABLE IS 'PLUG-IN' COMPATIBLE. WIRE TO 37D OR ELCO CONNECTOR AS SHOWN.

Fig. 13 - Radio Interface Drawing
RCA Veetac

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																				
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
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1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97		98		99		100	
1		2		3		4		5		6		7		8		9		10		11		12		13		14		15		16		17		18		19		20		21		22		23		24		25		26		27		28		29		30		31		32		33		34		35		36		37		38		39		40		41		42		43		44		45		46		47		48		49		50		51		52		53		54		55		56		57		58		59		60		61		62		63		64		65		66		67		68		69		70		71		72		73		74		75		76		77		78		79		80		81		82		83		84		85		86		87		88		89		90		91		92		93		94		95		96		97							

Fig. 14 – Future Radio Interface Drawing

000-000-000-000

000-000-000-000

000-000-000-000

Fig. 15 – Future Radio Interface Drawing

2025 RELEASE UNDER E.O. 14176

Fig. 16 – Future Radio Interface Drawing

000-000-00000-1 set

000-000-00000-1 set

000-000-00000-1 set

Fig. 17 – Future Radio Interface Drawing

Fig. 13 - Future Radio Interface Example

Fig. 18 – Future Radio Interface Drawing

000-000-000-000

Page 10 - Home Health Message Demand

000-000-000

Fig. 19 – Future Radio Interface Drawing

000-000-000-000

18 - Human Health Implications Draft Final

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2.14 If a current meter is available on the power supply, check the current drain. The GL 2020 draws 160 - 260 mA depending on the contents of the LED display, while the radio receiver typically draws a few hundred millamps.

PROGRAMMING

2.15 The GL 2020 control head provides a special technician mode of operation to allow the service technician to program the "personality" of the unit and align the unit to the radio being used. The personality of the unit is contained in 10 technician memories described in Table 3.

Technician Mode

Note: Throughout this section the [?] indicates any digit key (0 to 9) unless otherwise specified.

2.16 The technician mode can be entered at any time from the normal operating mode by executing a special key sequence:

TOUCH [8] [3] [2] [4] [F] [0]

Note: This is equivalent to dialing:

[T] [E] [C] [H] [F] [0]

The unit will respond by flashing on the display [TECH]. To exit from the technician mode, turn the unit off (TOUCH AND HOLD [ON]) and then back on again. This restores normal operation.

2.17 If the technician mode was entered after a memory failure was detected in the normal operating mode, some action upon the personality memories is required in order to reset the memory failure i.e. at least one memory must be reviewed.

Memory Review

2.18 Prior to programming the head for the required parameters, all technician memory locations should be reviewed:

TOUCH [M]

TOUCH [?]

for each of the 10 memories. See the contents of each memory displayed.

Identification Programming

2.19 The three (3) possible identification numbers used for decoding incoming calls and for automatic call placement are contained in personality memories M1, M2 and M3, respectively. Each of these identification numbers can be programmed for up to seven (7) digits. No association is made between the identification numbers and any signalling scheme, i.e. any identification number can be assigned to any signalling type.

TO PROGRAM IDENTIFICATION NUMBER:

ENTER THE DESIRED ID NUMBER

TOUCH [F]

TOUCH [M]

TOUCH [?] - where ? = 1, 2 or 3

Memory #	Description	No. of Digits
M1	Identification (ID) Number 1	Up to 7 digits
M2	Identification (ID) Number 2	Up to 7 digits
M3	Identification (ID) Number 3	Up to 7 digits
M4	Total Lock Code	Up to 4 digits
M5	RX Only Lock Code	Up to 4 digits
M6	Optional Feature Enables	Number 0 - 255
M7	Radio Channel Format	Number 0 - 255
M8	First Billing Warning Interval	Number 1 - 255
M9	Subsequent Billing Warning Interval	Number 1 - 255
M0	Dial Tone Detection Frequency	Number 300 - 3000

Table 3 - Technician Programming Memories

See the display show the new contents of the chosen identification memory.

Note: Even if only one ID is used all three memories must be programmed (use the same number).

Total Lock Code Programming

2.20 The total lock code (contained in memory M4) allows the user to lock his unit, so that calls cannot be placed or received. The Unit may still decode calls, so that [CALL] flashes on the display when the Unit is eventually unlocked.

TO PROGRAM THE LOCK CODE:

ENTER THE DESIRED LOCK CODE (up to 4 digits)

TOUCH [F]

TOUCH [M]

TOUCH [4]

See the new lock code appear on the display.

Receive (RX) Only Lock Code Programming

2.21 The RX only lock code allows the Unit to receive calls while preventing calls from being placed. If a call is received the Unit rings even though the display is "dead".

TO PROGRAM THE RX ONLY LOCK CODE:

ENTER THE DESIRED LOCK CODE (up to 4 digits)

TOUCH [F]

TOUCH [M]

TOUCH [5]

See the new lock code appear on the display.

Note: The same lock code can be used for both types of lock.

Feature Enables Programming

2.22 Certain features of the GL2020 control head are optional, and their usage is controlled by personality memory M6. M6 is displayed and programmed as a number from 0 to 255. A feature can be enabled or disabled by adding a number to the contents of M6, as shown in Table 4.

TO PROGRAM FEATURE ENABLES:

ENTER FEATURE ENABLES NUMBER

TOUCH [F]

TOUCH [M]

TOUCH [6]

See display show the new feature enables control number.

Number	Description	Yes
Add 128	Billing warnings enabled *	
Add 64	Call duration on display enabled	
Add 32	Inhibit call placement if ignition off	
Add 16	Unit turns off upon ignition opening transition	
Add 8	User can program areas	
Add 4	Not used	
Add 2	20pps IMTS dialing Mobile to Land **	
Add 1	Not used	
Feature Enables Number		

Table 4 - GL2020 Feature Enables

Notes: * Billing warnings require call duration enabled.

** Instead of 10pps.

Radio Channel Format

2.23 The GL2020 control head is designed to interface to any popular VHF or UHF radio transceiver. In order to facilitate the wide variety of radio channel formats, a radio channel format control number is provided in personality memory M7. M7 is displayed and programmed as a number from 0 to 255. Refer to the relevant radio interface drawing to ascertain the correct M7 number.

Note: For non-standard radios refer to Appendix B.

TO PROGRAM RADIO CHANNEL FORMAT:

ENTER RADIO CHANNEL FORMAT NUMBER
TOUCH [F]
TOUCH [M]
TOUCH [7]

See display show the new radio channel format control number.

Billing Warning Intervals

2.24 During conversation the GL 2020 can provide audible billing warnings if programmed to do so. The intervals at which these audible warnings are given are defined by personality memories M8 and M9 - where M8 defines the first billing warning interval and M9 defines the subsequent billing warning interval.

2.25 Both these intervals are defined in multiples of 10 seconds and are restricted to 2550 seconds maximum.

TO PROGRAM BILLING WARNING INTERVALS:

ENTER DESIRED INTERVAL (in multiples of 10 seconds)
TOUCH [F]
TOUCH [M]
TOUCH [8] or [9]

See the display show the new number of 10 second times between intervals.

Dial Tone Detect Programming

2.26 The frequency of the dial tone which will be looked for in the automatic call placement procedure can be programmed directly

by the service technician in personality memory M0. The dial tone detect frequency can be programmed to be any frequency between 300 and 3,000Hz.

TO PROGRAM DIAL TONE DETECT FREQUENCY:

ENTER FREQUENCY
TOUCH [F]
TOUCH [M]
TOUCH [0]

See the display show the new dial tone detect frequency.

Note: Standard dial tone frequency is 440Hz.

Area Programming

2.27 It is essential to program all 10 user areas. An ID must be selected for each area.

TO PROGRAM AREAS:

Note: Each area is programmed in the same way.

HANDSET ON HOOK
TOUCH [F]
TOUCH [A]
TOUCH [?] - where ? is the area number
Display will flash [A? PROG].
TOUCH [1]

This means "yes". If any other key is touched programming is inhibited.

Unit will display [A? IMTS]

If IMTS is required respond by touching [1] for "yes"
or

If IMTS is not required touch [0] for "no", in which case the Unit will display [A? 2805] which must either be accepted (in which case the display shows the next prompt) or denied (in which case the Unit displays [A? MTS].

Follow the prompts to select the ID number and the selected channels responding with [1] for "yes" and [0] for "no".

To exit from the programming mode:

TOUCH [C]

2.28 For reference, Tables 5 and 6 show standard channel designations and frequencies. Check that your radio is, crystalized correctly.

VHF ("MJ" SYSTEM)			UHF ("MK" SYSTEM)		
Channel	Mobile RX	Mobile TX	Channel	Mobile RX	Mobile TX
JJ*	152.48	157.74	QC	454.375	459.375
JL	152.51	157.77	QJ	454.400	459.400
YL	152.54	157.80	QD	454.425	459.425
JP	152.57	157.83	QA	454.450	459.450
YP	152.60	157.86	QE	454.475	459.475
YJ	152.63	157.89	QP	454.500	459.500
YK	152.66	157.92	QK	454.525	459.525
JS	152.69	157.95	QB	454.550	459.550
YS	152.72	157.98	QQ	454.575	459.575
YR	152.75	158.01	QR	454.600	459.600
JK	152.78	158.04	QY	454.625	459.625
JR	152.81	158.07	QF	454.650	459.650
JW*	152.84	158.10			

Table 5 - Telco Frequency Assignments

* Canada only.

VHF			UHF		
Channel	Mobile RX	Mobile TX	Channel	Mobile RX	Mobile TX
1	152.03	158.49	21	454.025	459.025
3	152.06	158.52	22	454.050	459.050
5	152.09	158.55	23	454.075	459.075
7	152.12	158.58	24	454.100	459.100
9	152.15	158.61	25	454.125	459.125
11	152.18	158.64	26	454.150	459.150
13	152.21	158.67	27	454.175	459.175
			28	454.200	459.200
			29	454.225	459.225
			30	454.250	459.250
			31	454.275	459.275
			32	454.300	459.300
			33	454.325	459.325
			34	454.350	459.350

Table 6 - RCC Frequency Assignments

2.29 Finally if it is desired to prevent unauthorized persons from changing the ID code, or other parameters, cut jumper JR 206 on the MPU module. Anyone attempting to reprogram the Unit will be able to enter the TECH mode, but will get an [ERROR] display when trying to change memory contents.

Other Technician Features

2.30 The technician mode includes a number of the features used in the normal operating mode as well as a few additional capabilities, as summarized in Table 7.

2.31 In the OFF HOOK state in the technician mode, the operation of the push-to-talk switch in the handset controls the operation of the radio transmit key directly, allowing the technician to engage in conversation or set radio deviation levels. The speaker is always on in the technician mode, except when the handset is off-hook.

Tone Detector Feature

2.32 Set desired frequency as in "Transmit Tone" (Table 7):

TOUCH [#]

If the tone detector detects a tone, it puts the word [DETECT] on the display. If not, the word [TECH] is displayed. To exit this feature:

TOUCH [C]

Note: This mode is very useful in establishing the RF coverage area. Enter this mode in the mobile and drive around, monitoring the 2000Hz idle tone.

ADJUSTMENT AND ALIGNMENT

Introduction

2.33 This section provides instructions to the technician to adjust both the control head and the radio audio levels, and to check the basic operation of the radiotelephone. (This procedure is complicated by the wide variety of radio interfaces and features; for example, some radios have a receive audio volume control, others do not). Once the radio and control head are connected to each other and the GL2020 is programmed, connect a dummy antenna and proceed as follows:

Preliminary Squelch Adjustment

2.34 Enter the technician mode as follows:

TURN UNIT [ON]

HANDSET ON HOOK

TOUCH [8][3][2][4] [F][0]

Observe the word [TECH] on the display

Function	Operation
Volume Up (Speaker volume on-hook, Earpiece volume off-hook)	TOUCH [F] TOUCH AND HOLD [1]
Volume Down (Speaker volume on-hook, Earpiece volume off-hook)	TOUCH [F] TOUCH AND HOLD [2]
Current Channel Review	TOUCH [F] TOUCH AND HOLD [7]
Call Duration Recall	TOUCH [F] TOUCH AND HOLD [8]
Channel Advance	OFF HOOK TOUCH [A]
Transmit Tone*	ON HOOK ENTER FREQUENCY (in Hz) TOUCH [S] TOUCH [C] to stop
Transmit Voice	OFF HOOK PRESS PTT WHILE TALKING
Area Review	ON HOOK TOUCH [M] TOUCH [A]
Area Select	ON HOOK TOUCH [A] TOUCH [?]
Area Program	ON HOOK TOUCH [F] TOUCH [A] TOUCH [?]

Table 7 - Technician Features

* The generated tone frequency may differ slightly from that entered, due to finite resolution in the digital tone generator circuit. The discreet frequency resolution is given by $f = 576/N$ kHz, where N is a whole number. For example if it is desired to generate 1004Hz then N = 574 gives f = 1003.4 Hz as the nearest frequency. The tone detector resolution is twice that of the tone generator, i.e. $f = 1152/N$ kHz.

TOUCH [C] to clear the display

Verify that a suitable area and channel list is selected and programmed.

TOUCH [M] [A]

If desired, select a different area and channel list.

TOUCH [A]

TOUCH [?] where ? is from 0 to 9

2.35 Check the receive audio:

HANDSET OFF HOOK

LISTEN IN THE EARPIECE.

TOUCH [A] to advance channels.

***** IMPORTANT *****

Adjust Radio Squelch for unsquelched audio (if radio has squelch circuit). The radio squelch is adjusted for permanently unsquelched audio to permit the GL2020 tone detector to operate correctly.

2.36 The squelch control is normally located in the radio (consult radio manual or GL2020 interface drawing). In a few cases the radio squelch is controlled by trimpot R405 in the GL2020 (consult interface drawing to see if this is so). Adjust the squelch control until noise hiss is heard on a free channel.

To find a free channel:

TOUCH [A]

Receive Level Adjustment

2.37 Apply an RF signal to the radio, either by connecting an RF generator to the sampling port of the dummy antenna load (if the dummy load has a sampling port), or fit an antenna to the RF generator, and locate it near the dummy load.

2.38 Tune the RF generator to the mobile RX frequency corresponding to the channel selected on the control head. This channel should be one that is not used in the local environment, to avoid interference during the adjustment procedure.

2.39 Modulate the RF generator with a 1000Hz tone at 3500Hz deviation.

2.40 With the unit still in the technician mode from before, listen to the tone in the earpiece, and adjust the volume up or down (refer to paragraphs 3.14 and 3.15). When the display shows a volume level of 3 or 4 the perceived level should be quite loud but not distorted. A volume level of 7 should be very loud and piercing, a level of 1 should be relatively subdued. If the RX level appears incorrect, adjust it, using the VOL control in the radio (or in some cases the radio VOL control is R404 inside the GL2020 - consult interface drawing). Only in those cases where the radio has no VOL adjustment should the receive level be adjusted using the RX LEVEL trimpot in the GL2020. This control is accessible through the hole in the case - see Fig. 2.

Tone Detector Check

2.41 This check provides a precise method of repeating the RX level adjustment above, and checks that the tone detector is operating correctly. With the test set-up as above, readjust the generator to generate 1000Hz at 1000Hz deviation.

2.42 Set the GL2020 tone detector to detect 1000Hz:

TOUCH [1][0][0][0]

TOUCH [S]

TOUCH [C]

then

TOUCH [#]

to put in the tone detect/display mode. If the tone is detected the word [DETECT] appears. If not, the word [TECH] is displayed instead.

2.43 If the word [DETECT] does not appear, readjust the RX VOL (or RX level) as above until it does. Note that the detector is now set to detect a low level tone, giving it a reasonable margin with noise.

TOUCH [C]

after the check is completed.

Note: If difficulties are encountered with the above then the following procedure may be followed:

2.44 RF generator set for 1000Hz at 3500Hz deviation. Adjust VOL (if fitted) or RX LEVEL for 200mV peak-peak at Test Point TP401 on Interface module - consult Fig. 34 to determine location of TP401 (approximately in the center of the board).

2.45 Repeat tone detection check as above.

Speaker Amplifier Check

2.46 With the test setup as above, and the GL2020 in the tech mode, set the RF generator for 1000Hz modulation at 3500Hz deviation.

PUT THE HANDSET ON HOOK

LISTEN TO THE TONE IN THE SPEAKER

ADJUST THE VOLUME

to ensure that reasonable volume levels are obtained.

Transmitted Tone Level Adjustment

2.47 This adjustment sets the 2150Hz IMTS "guard" tone to a deviation level of 4000Hz. If the radio is equipped with a deviation adjustment control this control should be used. Many radios, however, have only deviation limit controls, in which case the TX TONE adjustment control in the GL2020 is to be used instead (consult Fig. 2 for location). Test set up as above, with the GL2020 in tech mode and dummy antenna load connected to radio. Tune the communications monitor to the mobile TX frequency of the selected channel.

PUT THE HANDSET ON HOOK!

Send a 2150Hz tone from the control head

TOUCH [2][1][5][0]

TOUCH [S]

***** CAUTION *****

Transmitter comes on

2.48 Turn the deviation control (or TX TONE) fully "up" to check that the radio deviation limit control is correctly adjusted to limit at 4.5 to 5KHz. Adjust if necessary.

2.49 Turn the deviation control (or TX TONE) "down" until a deviation of 4KHz is obtained.

2.50 Check that the IMTS "Disconnect" tone of 1336Hz gives acceptable deviation.

TOUCH [1][3][3][6]

TOUCH [S]

and check that the deviation remains above 3KHz.

TOUCH [C] to turn off the transmitter

Note: The control head is factory adjusted to give between 0dBm (2.2 volts peak to peak) and -6dBm (1.1 volts peak to peak) to the radio. This type of level provides best audio quality.

Transmitted Voice Level Adjustment

2.51 This adjustment may only be performed once the tone level has been adjusted as above.

2.52 With the test set up per paragraph 2.44 and with the GL2020 in tech mode:

LIFT THE HANDSET

HOLD THE PTT SWITCH TO TRANSMIT

Speak into the microphone and adjust the TX VOICE trimpot in the GL2020 (consult Fig. 2 for location) for 3000 to 4000Hz average deviation, or as appropriate.

Note: Do not adjust the radio deviation as it will affect the previous tone adjustment.

Final Pre-Installation Check

2.53 SWITCH THE UNIT OFF

REMOVE THE DUMMY LOAD AND CONNECT A PROPER ANTENNA

SWITCH THE UNIT ON

2.54 Select the home area. Verify that all 10 areas are programmed by selecting each in turn:

i.e. TOUCH [A][1] - observe display
TOUCH [A][2] - observe display
etc.

2.55 Program the end user's 9 repertory memories (if contents are known).

2.56 Select the "home" area and place and receive test calls. Adjust earpiece and speaker volumes as appropriate.

2.57 Put the user's telephone number in the telephone number insert.

2.58 Put the unit in the tech mode and review and correct if necessary the user's ID numbers, lock codes, billing warnings, etc.

INSTALLATION

2.59 The GL2020 control unit consists of the control head, handset and mounting base assembly. A modular coil cord connects the handset to the control head.

2.60 Connection between the control head and the radio cable is by means of the integral multiconductor control cable. Optional wiring to ignition key and horn is via a "breakout" connector.

PHYSICAL INSTALLATION

2.61 The installation requires the following operations:

- (1) Mounting the control head assembly in the passenger compartment.
- (2) Connecting the control cable to the existing radio cable.
- (3) Connecting the option wiring.

2.62 Select a suitable location for the control head. The vehicle operator's convenience is the main criteria. Avoid locations that may impair the operation of the vehicle. Do not place the control head in front of heater outlets.

2.63 The junction of the radio cable and the control head control cable should be positioned in a secure location - i.e. under front seat or under dash area.

2.64 Where cables or wiring are routed through the firewall or other partitions, grommets should be used to avoid damage to the cabling.

***** WARNING *****

Extreme care must be exercised when drilling or punching any mounting holes.

Ensure that no damage will be caused to vehicle wiring, transmission, fuel or brake lines or the fuel tank itself.

Prior to power connections being made remove the negative connection to the vehicle battery.

2.65 Physical Installation Procedure:

- (a) Determine location of mounting base and using body and bracket assembly as a guide (see Fig. 20), drill three No. 26 (.147") (3.6mm) diameter holes to accept

the sheet metal screws supplied with the installation kit.

Note: The bracket legs will bend to adjust to precise mounting location.

- (b) After body and bracket assembly has been securely mounted to vehicle body, place ball and stem assembly onto "cup" of body and bracket assembly.

Note: Ball must remain free of grease and oil. Do not lubricate.

- (c) Slip clamp cup over ball and stem assembly. Place clamp nut over entire assembly and hand-tighten onto body threads.

- (d) Slide stem of ball and stem assembly into adapter plate on control head. Using a 1/8" Allen wrench, tighten set screw into recessed portion of stem.

- (e) Rotate control head into most desirable position and firmly tighten clamp nut.

- (f) Attach the control cable assembly to the radio cable. Ensure connectors are locked together with hardware supplied (Fig. 21).

ELECTRICAL INSTALLATION

***** CAUTION *****

Vehicle battery ground strap must be removed when making electrical connections.

2.66 Two options are available with the GL2020:

- (a) Ignition Enable (Refer to Fig. 22)

Use this if the following is desired:

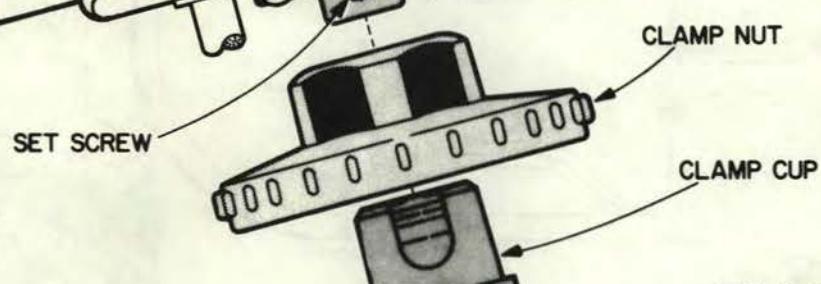
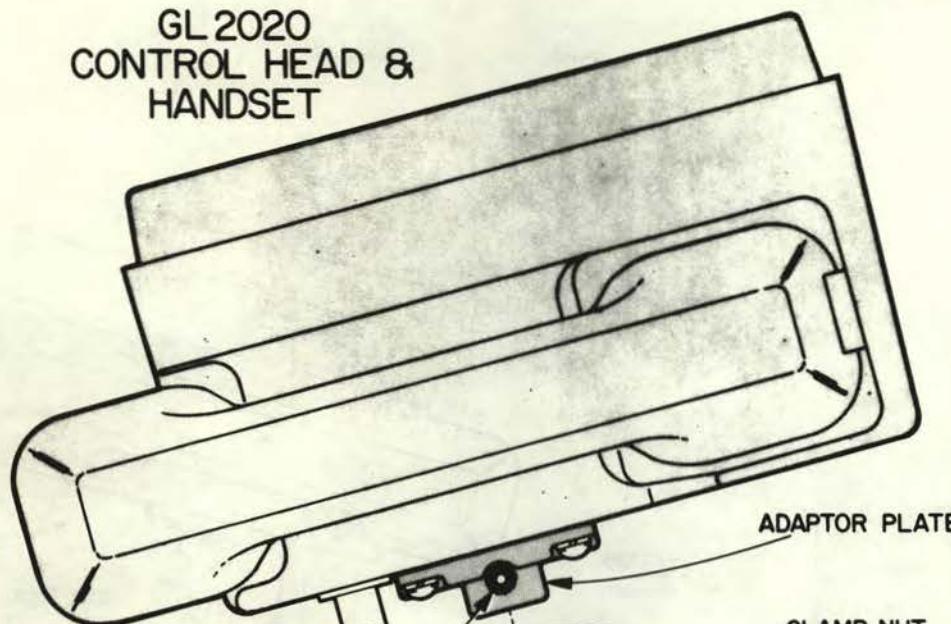
- Unit cannot place calls with ignition off
- Unit switches off with ignition key

- (1) On the 3 pin "breakout" connector wire the red wire (18g.) to one side of an inline fuseholder.

- (2) Ensure 1A fuse installed.

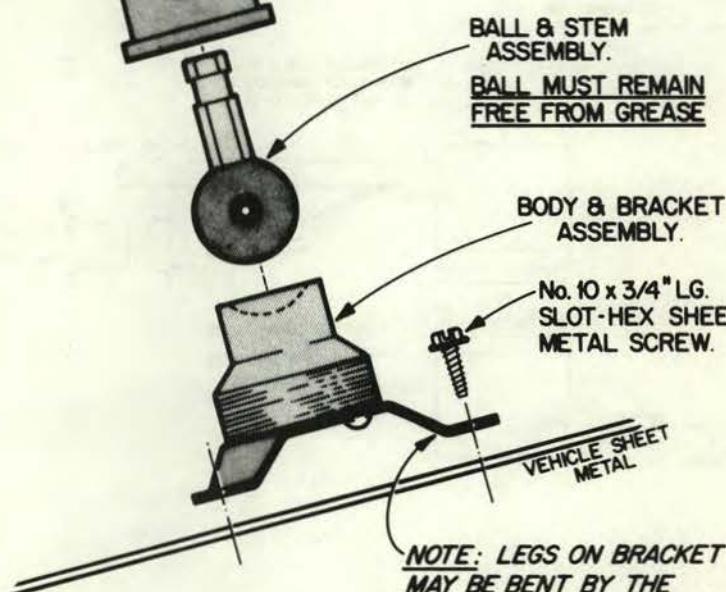
- (3) Wire other side of fuseholder to ignition +12v.

GL 2020
CONTROL HEAD &
HANDSET



INSTALLATION PROCEDURE

1. DETERMINE LOCATION OF MOUNTING BASE AND, USING BODY & BRACKET ASS'Y. AS A GUIDE, DRILL THREE No. 26 (.147") DIA. HOLES TO ACCEPT THE SHEET METAL SCREWS SUPPLIED WITH THE INSTALLATION KIT.
2. AFTER BODY & BRACKET ASS'Y. HAS BEEN SECURELY MOUNTED TO VEHICLE SHEET METAL, PLACE BALL & STEM ASS'Y. ONTO 'CUP' OF BODY & BRACKET ASSEMBLY. SLIP CLAMP CUP OVER BALL & STEM ASS'Y. PLACE CLAMP NUT OVER ENTIRE ASSEMBLY AND HAND-TIGHTEN ONTO BODY THREADS.
3. SLIDE STEM OF BALL & STEM ASS'Y. INTO ADAPTOR PLATE ON CONTROL HEAD. USING A 1/8" ALLEN WRENCH, TIGHTEN SET SCREW INTO RECESSED PORTION OF STEM.
4. ROTATE CONTROL HEAD INTO MOST DESIRABLE POSITION AND FIRMLY TIGHTEN CLAMP NUT.



NOTE: LEGS ON BRACKET
MAY BE BENT BY THE
INSTALLER TO CONFORM
WITH VEHICLE SHEET
METAL CURVATURES.

Fig. 20 - Control Head and Mounting Base Installation

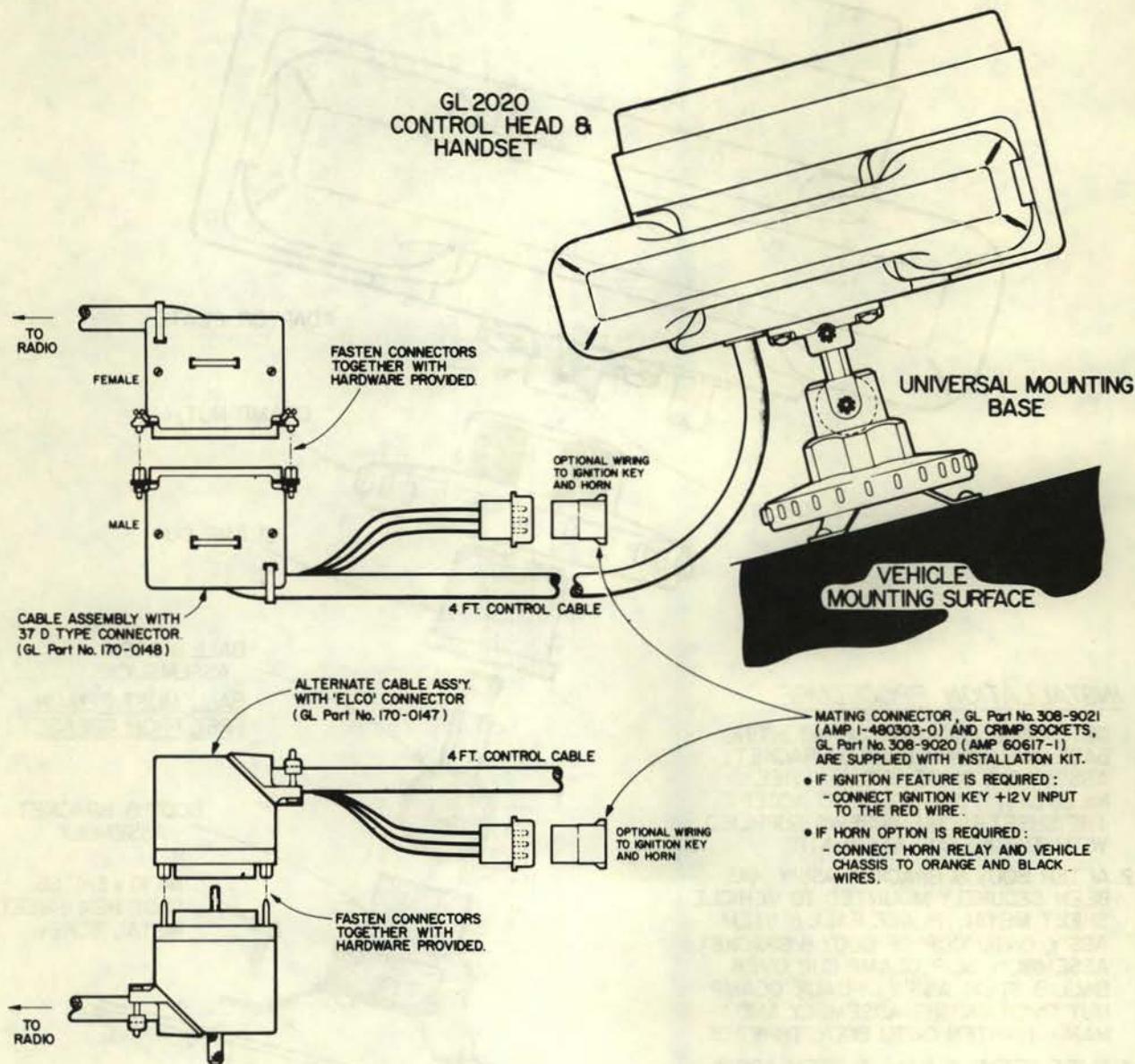
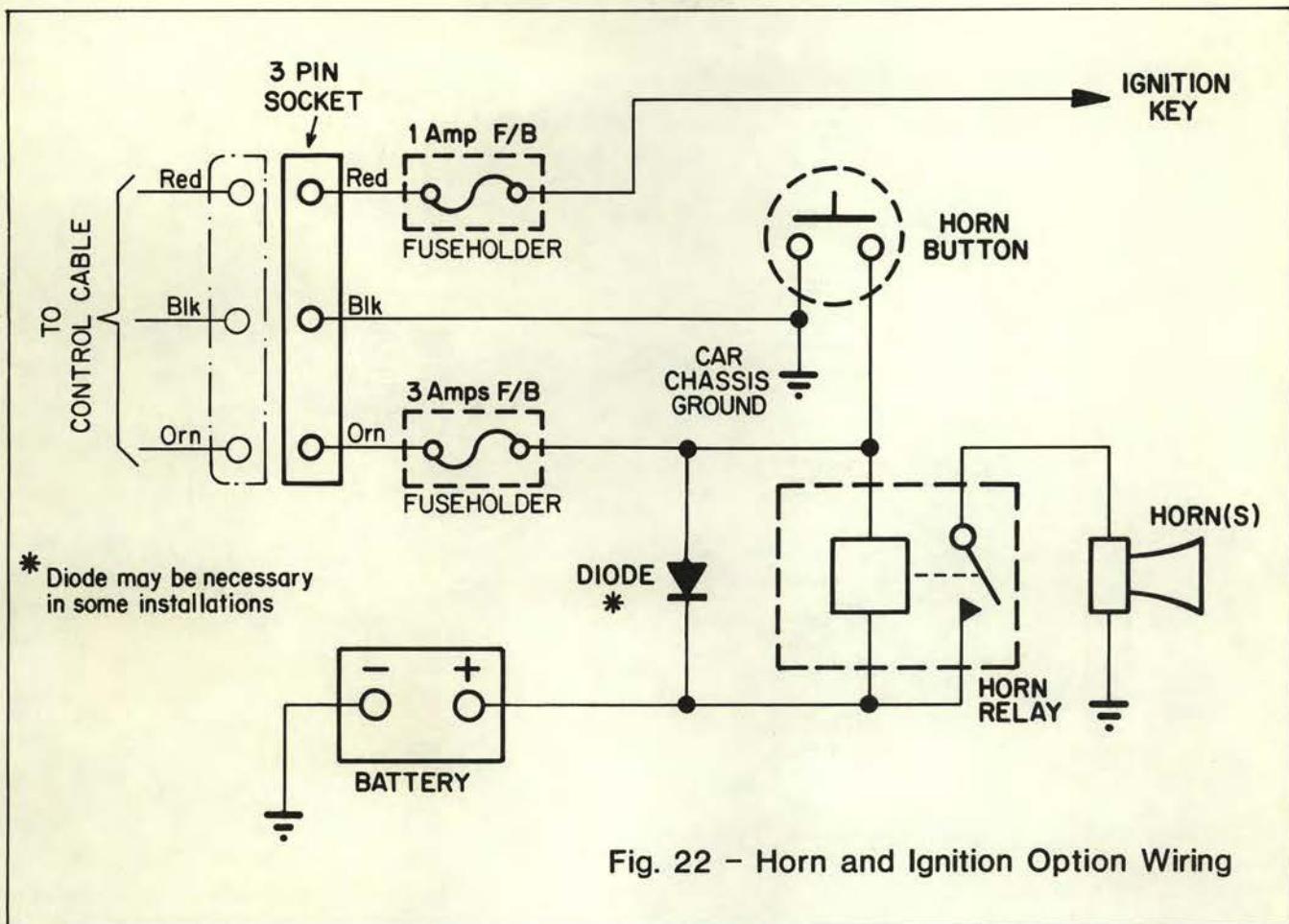


Fig. 21 – Control Head Cable Installation



(b) Horn Enable (Refer to Fig. 22)

Use this if external vehicle horn alert is desired on incoming calls.

- (1) On the 3 pin "breakout" connector wire the orange wire (18g.) to one side of an inline fuse holder.
 - (2) Ensure 3A fuse installed.
 - (3) Wire other side of fuseholder to vehicle horn relay.

***** CAUTION *****

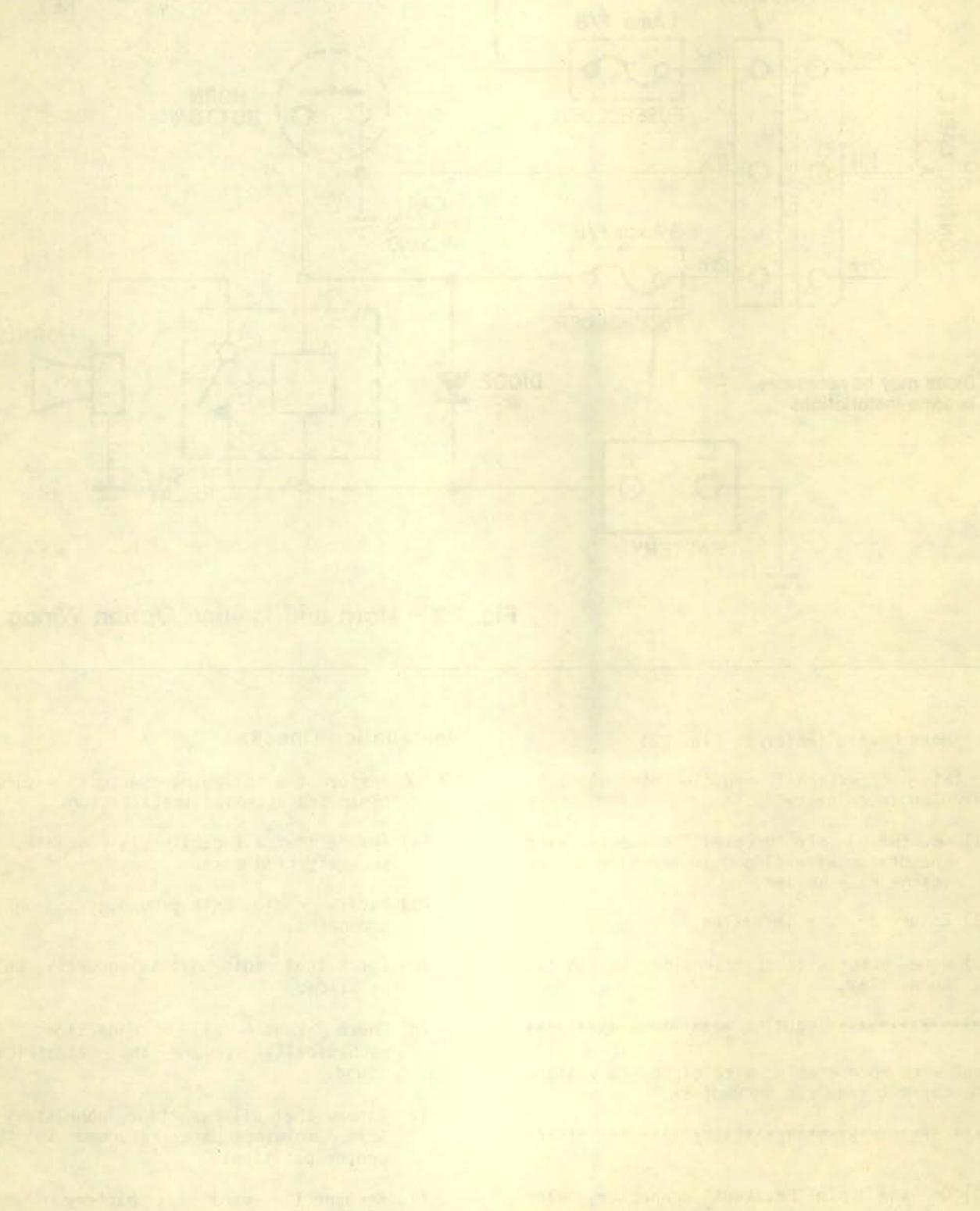
Do not wire horn enable wire direct to vehicle horn. Current required exceeds 8A.

- (4) On the 3 pin "breakout" connector, wire the black wire to chassis ground.

Installation Checks

2.67 Perform the following checks to ensure a clean professional installation.

- (a) Ensure that all cabling is concealed and securely tied down.
 - (b) Verify radio unit grounding and antenna grounding.
 - (c) Check that radio unit is securely bolted in place.
 - (d) Check that all connections are mechanically secure and electrically sound.
 - (e) Ensure that all carpeting, upholstery and trim moldings are returned to their proper position.
 - (f) Reconnect vehicle battery ground connection.



Operating
Instruction

Chapter 3

Operating Instructions

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Chapter 3

Selected Institutions

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3. OPERATING INSTRUCTIONS

GENERAL

3.01 Each unit comes complete with a small user's manual with instructions on operating the Unit. The installing technician should be thoroughly familiar with the contents. The following description provides a brief overview, to refresh the reader's memory. Fig. 23 shows the Unit's keypad and display layout.

POWER ON/OFF

3.02 TO TURN THE UNIT ON:

TOUCH [ON]

Note: This also turns the radio receiver on.

See [GL2020 A] appear on the display. If it does not, the unit may be locked (see paragraph 3.25).

3.03 TO TURN THE UNIT OFF:

TOUCH AND HOLD (BRIEFLY) [ON]

Note: The key is "debounced" to prevent inadvertent switch off. In case of gross electronic malfunction, the unit may be turned off by depressing the [ON] key for 2 seconds.

RECEIVING A CALL

3.04 Procedure for receiving a call is the same regardless of signalling type.

THE UNIT RINGS

[CALL] FLASHES ON THE DISPLAY

LIFT HANDSET AND TALK

Note: If the call is answered during the first ring, the ring is not tripped immediately. It is arranged like this to provide one full ring if a call is received while the user is "queued" mobile-to-land.

If the user is out of the car when a call is received then [CALL] will remain on the display.

PLACING A CALL (IMTS)

3.05 There are five ways to place a call:

(a) Standard Telephone Operation

LIFT HANDSET

WAIT FOR DIAL TONE

DIAL WHEN YOU HEAR DIAL TONE

Note: The call is cancelled if you do not dial within 20 seconds. Do not pause longer than 5 seconds between digits.

(b) Standard Telephone Operation (Memory Dial)

LIFT HANDSET

WAIT FOR DIAL TONE

TOUCH [M]

TOUCH [?]

This will dial the contents of the chosen memory.

Note: The tenth memory [0] is used to dial "0" for the mobile operator.

(c) On-Hook Dialing

HANDSET ON-HOOK

ENTER TELEPHONE NUMBER

TOUCH [S]

LIFT HANDSET WHEN YOU HEAR THE NUMBER RINGING

To cancel the call if the called party is busy or the call goes astray:

TOUCH [C]

(d) On-Hook Memory Dialing

HANDSET ON-HOOK

TOUCH [?]

This selects one of the ten memories.

TOUCH [S]

See the telephone number contained in that memory step across the display.

NOTE: ALL KEYS ARE ILLUMINATED
FOR NIGHT OPERATION.

DECIMAL POINT -
'ON' INDICATOR
FOR BLANK DISPLAY.

POWER ON/OFF -
TOUCH 'ON'
PRESS 'OFF'

CLEAR KEY -
- CLEARS ERRORS.
- CANCELS 'ON-HOOK'
CALL ATTEMPTS.

MEMORY KEY -
FOR MEMORY REVIEW:
- Touch 'M'
- Touch a 'Digit'
FOR MEMORY STORAGE:
- See FUNCTION KEY

SEND KEY -
FOR 'ON-HOOK' DIALING:
- Handset On Hook
- Enter Phone Number
(or select Memory
Number)
- Touch 'S' Key
FOR LAST NUMBER RE-DIAL:
- Touch 'S' Key

ASTERISK KEY -
USED FOR SECONDARY
DIAL TONE DETECTION.

DISPLAY - 8 CHARACTERS

TX LIGHT -
INDICATES WHEN
RADIO TRANSMITTER
IS ON.

AREA KEY -

SELECTION:

- Touch 'A'

- Touch a digit

REVIEW:

- Touch 'M'

- Touch 'A'

FUNCTION KEY -

- TOUCH 'F'

- TOUCH A 'DIGIT':

F1 : Volume Up

F2: Volume Down

F3: Simplex

'CODE' F4: Total Lock

'CODE' F5: RX Lock

F6: Horn On / Off

F7: Current Channel

F8: Call Duration

F9: Not Used

F0: (Technician Only)

- STORING NUMBERS
IN MEMORY:

: Enter Number

: Touch 'F'

: Touch 'M'

: Touch a 'Digit'

TELEPHONE KEYS
(DIGITS)

END KEY -

PRESS TO TERMINATE
A CALL : ALLOWS RE-
DIALING WITHOUT
HANGING UP HANDSET.TELEPHONE NUMBER
LABEL

Fig. 23 - GL2020 Controls and Displays

Lift the handset when you hear the number ringing.

(e) Last Number Redial

HANDSET ON HOOK

TOUCH [S]

The last number dialed or entered is recalled, and the call proceeds as above.

3.06 When placing a call if no channels are available, the word [WAIT] appears on the display. Wait and the Unit will place your call automatically if a channel becomes free within 4 minutes. Busy tone is in the earpiece during the wait condition. See Appendix A (Bell Queuing Algorithm).

3.07 If your call cannot be placed for various reasons, the Unit will emit a short "beep" sound as it cancels the call attempt, and [WAIT] will be blanked out.

3.08 If the handset is off hook after the call is cancelled, Receiver Off Hook (ROH) tone is heard in the loudspeaker (loud beeps, 4 per second). Replace the handset.

3.09 During call placement, the Unit briefly displays the area and channel numbers eg [A3 CH 02] for area 3, channel 2.

3.10 A call can be received while you are placing a call. Answer it in the usual manner.

PLACING A CALL (MANUAL)

3.11 In MTS or 2805 areas:

LIFT HANDSET

FLICK PTT SWITCH TO ADVANCE TO DESIRED CHANNEL

HOLD PTT SWITCH FOR 2 SECONDS UNTIL TX LIGHT COMES ON

WAIT FOR OPERATOR TO ANSWER

IF THERE IS NO OPERATOR ANSWER, HANG UP OR TOUCH [#]

DURING CONVERSATION

Call Duration Timer and Billing Warnings

3.12 The call duration timer, in minutes and seconds, will appear on the display. The

unit emits a short beep in the speaker 10 seconds before the next billing period (if the technician programming has enabled this feature.)

Scratchpad

3.13 A telephone number may be entered onto the display during conversation. To call the scratchpad number, hang-up and touch [S].

Volume Up

3.14 To turn the volume up (earpiece off-hook, speaker on-hook):

TOUCH [F]

TOUCH AND HOLD [1]

See [VOL UP n] appear on the display, where n is a number from 1 (soft) to 7 (loud). The volume increases as [1] is held. Release [1] when the desired volume is reached.

Note: The earpiece and speaker volume controls are completely independent. Changing one has no effect on the other.

Volume Down

3.15 To turn the volume down (earpiece off-hook, speaker on-hook):

TOUCH [F]

TOUCH AND HOLD [2]

See [VOL DN n] appear on the display, where n is a number from 1 (soft) to 7 (loud). The volume decreases as [2] is held. Release [2] when the desired volume is reached.

Last Number Review

3.16 To review the last number dialed:

TOUCH [M] [M]

Simplex/Duplex

3.17 To select simplex if desired:

TOUCH [F]

TOUCH [3]

To revert to duplex repeat the above sequence. Duplex is automatically selected on power up or after a call.

AFTER CONVERSATION

End Conversation

3.18 The conversation may be ended by:

- (a) Hanging up
- (b) Touching [#] - this will "re-order" without having to hang up.

Call Duration Recall

3.19 To recall the call duration of the last conversation:

TOUCH [F]
TOUCH AND HOLD [8]

This will display the time for as long as [8] is depressed.

AREA FEATURES

Area Selection

3.20 To select one of the 10 areas:

HANDSET ON HOOK
TOUCH [A]
TOUCH [?]

The Unit selects the appropriate signalling mode, ID number, and channel list for that area.

Area Programming

3.21 This feature can be enabled/disabled during technician programming.

HANDSET ON HOOK
TOUCH [F]
TOUCH [A]
TOUCH [?]

See [A? PROG] flashing on the display (unless this feature is disabled to the user, in which case [ERROR] appears).

TOUCH [1]

This means "Yes". If any other key is touched programming is inhibited.

Follow the prompts on the display, responding with [1] for "Yes", [0] for "No".

Exit the programming mode by:

TOUCH [C]

Area Review

3.22 To review the current area :

HANDSET ON HOOK
TOUCH [M]
TOUCH [A]

Observe the area attributes appear on the display.

ELECTRONIC LOCKS

Total Lock

3.23 To totally lock the Unit:

ENTER LOCK CODE (up to 4 digits)
TOUCH [F]
TOUCH [4]

The Unit will appear to be "dead", although it still decodes, so as to be able to put a [CALL] indicator on the display when unlocked.

Note: The Unit does not "ACK" calls while totally locked

Receive Only Lock

3.24 To lock the unit so that it may still receive calls:

ENTER LOCK CODE (up to 4 digits)
TOUCH [F]
TOUCH [5]

The unit appears dead, but will ring and can be answered if a call is received.

Unlock

3.25 Procedure is the same for both types of lock.

ENTER LOCK CODE
TOUCH [M]
TOUCH [C] TO CLEAR LOCK CODE

Note: Lock codes for "total" and "receive only" may be the same or different, at the user's option. The technician programs the codes.

MEMORY FEATURES

3.26 There are nine repertory memories, each 16 digit capacity. They can be reviewed or stored in either the on-hook or the off-hook state, and while the phone is idle, or during conversation.

Memory Review

TOUCH [M]

TOUCH [?]

Memory Store

ENTER TELEPHONE NUMBER

TOUCH [F]

TOUCH [M]

TOUCH [?]

MISCELLANEOUS FEATURES

Horn

3.27 To select horn on:

TOUCH [F]

TOUCH [6]

See [HORN] flashing on the display.

Should a call be received, the horn will blow, during the silence after the first and second rings only.

Repeat to turn off.

Current Channel Review

3.28 To review the current channel:

TOUCH [F]

TOUCH AND HOLD [7]

The channel that was selected at the time [7] was pressed is displayed. This feature permits the technician to verify that scanning or locking onto idle tone is occurring.

Ignition

3.29 Depending on the programming and vehicle hook up, the Unit can either:

- ignore the ignition switch input
- inhibit call placement (but not reception) if the ignition is off
- turn off when the ignition is turned off

Timer

3.30 If not used for 24 hours, the unit turns itself (and the radio) off. The timer is reset by any action (key, handset, etc.) or by a vehicle power transient (such as when the motor is started).

Conversation Limit Timer

3.31 To prevent draining the vehicle battery, and to avoid expensive usage charges, the Unit turns the transmitter off if the handset is not hung up after 30 minutes of no key action. The Unit will not turn the transmitter off during conversation provided any key or the PTT switch is pressed at least once every 30 minutes. If you forget about the 30 minute limit, listen to determine if your party is still on the air. If they are push PTT to re-enable transmission. If your party is no longer on the air, hang up.

Service

3.32 A flashing [SERVICE] message indicates faulty memory contents for some reason. Check the programming in the technician mode or turn the Unit off! Do not leave a Unit switched on while needing [SERVICE].

БЕЗУПЕРФОРМЕННАЯ

ВИСОКОВОЛНОВАЯ

ННН

ННН

ННН

ННН

БЕЗУПЕРФОРМЕННАЯ

ННН

System Theory

Chapter 4

Theory of Operation

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Chapter 4

Utility of Operation

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4. THEORY OF OPERATION

GENERAL

4.01 This section contains a general description of Improved Mobile Telephone Service (IMTS), Mobile Telephone Service (MTS) and 2805 signalling systems.

IMTS SYSTEM OPERATION

4.02 An IMTS system consists of a Terminal, Base Station, and a number of Mobile units. The terminal provides control and interface of the base station to the telephone system. The base station provides the interface between mobile units and the terminal.

4.03 The terminal directly controls the operation of the base station. An idle tone is transmitted to provide an indication to all mobile units that the channel is available for calls.

4.04 The mobile unit is made up of a control unit and a transceiver. It decodes incoming signals from the base station and encodes signals which are transmitted to the base station. Generally the mobile unit does the following:

- (1) Scans on programmed channels, to locate the idle tone (2000Hz) and locks on that channel as long as idle tone present.
- (2) Decodes incoming signalling and sends an

Parameter	A.T.T. Spec.			GL2020
	Min.	Nominal	Max.	
Connect	315mS	350mS	385mS	367mS
Connect Interval	45mS	50mS	55mS	50mS
Answer Interval	287mS	400mS	763mS	400mS
ANI Pulse Time	20mS	25mS	30mS	25mS
Interpulse Time	20mS	25mS	30mS	25mS
Interdigit Time	130mS	190mS	280mS	191mS
Last Parity Bit	130mS	190mS	280mS	191mS
Disconnect Interval	500mS	750mS	1000mS	750mS
Disconnect Pulses	20mS	25mS	30mS	25mS
Acknowledge Interval	500mS	750mS	1000mS	750mS
Idle Tone to Stop Search	80mS	120mS	160mS	120mS
Hold On Fade of Idle Tone	*	140mS	*	143mS
Hold On Fade of Seize Tone	100mS		300mS	191mS
Connect Frequency	1623Hz	1633Hz	1643Hz	1632Hz
Disconnect Frequency	1328Hz	1336Hz	1344Hz	1336Hz
Guard Frequency	2138Hz	2150Hz	2162Hz	2149Hz
Idle Tone Frequency	1995Hz	2000Hz	2005Hz	2000(+20)Hz
Seize Tone Frequency	1795Hz	1800Hz	1805Hz	1800(+20)Hz
Interdigit Time (incoming)	250mS		5sec	160mS min
Dialing Pulses (from base)				
Idle	20mS		80mS	20-80mS
Seize	20mS		80mS	20-80mS

Per A.T.T. Publication 43301

Table 8 - GL2020 Tone Specs

* Should be greater than idle continuous tone.

Acknowledge tone if the received number matches the unit number.

- (3) On receipt of the ringing signal from the terminal, turns on an internal ring tone and displays the word [CALL].
- (4) When the mobile unit answers the call, a connect tone sequence is sent to the terminal.
- (5) Upon completion of the call, a disconnect tone sequence is transmitted.
- (6) If the mobile initiates the call, a connect sequence and the mobile identification number is sent.
- (7) Provides status indication of transmitter, control unit and radio channel information.

Marked Idle Tone

4.05 One idle channel in a system, if available for service, is "marked idle" by a 2000Hz steady tone. All mobiles scan and lock onto this tone. If any mobile seizes the channel, the signalling interchange causes the marked idle tone to drop, allowing all other mobiles to scan for a new mark idle tone on another channel.

Land to Mobile Calls

4.06 When a landside call is made to a mobile the signalling to the mobiles uses 2000 and 1800Hz "dial pulse" type frequency shift keying (Fig. 24). All mobiles remain locked onto the selective call until a wrong digit is detected, at which point scan resumes, until eventually only the called mobile remains on the channel. A seven digit numbering plan is generally used, where the mobile decoder "looks" for the three digit area code and the last four digits of the telephone number.

4.07 Mobiles are assigned an AAA-BBB-CCCC code. AAA is the area code or RCC number. BBB is the exchange number of the terminal. CCCC is the unique ID of the mobile in area code AAA.

4.08 When a local call is made, the land-side user dials BBB-CCCC; the terminal translates this to AAA-CCCC which is outpulsed to the mobile.

Automatic Acknowledge

4.09 The mobile automatically acknowledges receipt of a call, to give the terminal a positive indication that the call reached the proper mobile, even if the called subscriber is

out of the vehicle. On picking up the handset to answer the call, a connect tone burst indicates to the terminal that ringing should be stopped.

Automatic Disconnect

4.10 Whenever the handset is replaced on completion of conversation a "disconnect" tone burst indicates to the terminal that the call can be terminated.

Mobile to Land Calls

4.11 All calls from the mobile are preceded by a "handshaking" interchange of tones between the mobile and the terminal (Fig. 25). This is followed by an automatic ANI (Automatic Number Identification) to allow identification of the mobile for billing purposes. To prevent errors, the ANI "burst" uses a parity scheme.

Channel Queuing

4.12 Call attempts by the mobile, when all the channels are in use, cause [WAIT] to be displayed. The GL202 incorporates a queuing algorithm to minimize congestion caused by more than one waiting mobile seizing an idle channel at the same time. Refer to Appendix "A" for further details.

MTS SYSTEM OPERATION

4.13 An MTS system consists of an interconnect operator position, a base station and a number of mobile units. The interconnect position provides control and interface of the base station to the telephone system. The base station provides the interface between mobile units and the interconnect position.

4.14 The interconnect operator position directly controls the operation of the base station. A free channel is one on which no carrier is present. All signalling sequences are manually controlled. No direct dial operation is involved in MTS systems.

Land to Mobile Calls

4.15 Landside callers dial the mobile operator. Mobiles normally camp on one channel or in the case of the GL2020, scan looking for the 600Hz tone indicating start of dialing. See Fig. 26

4.16 Normally the signalling preamble uses 600Hz, although 1500Hz is encountered in a few areas.

4.17 The "clearing one" resets the mobile call decoders, which then decode the incoming digit train. If the received digits match the

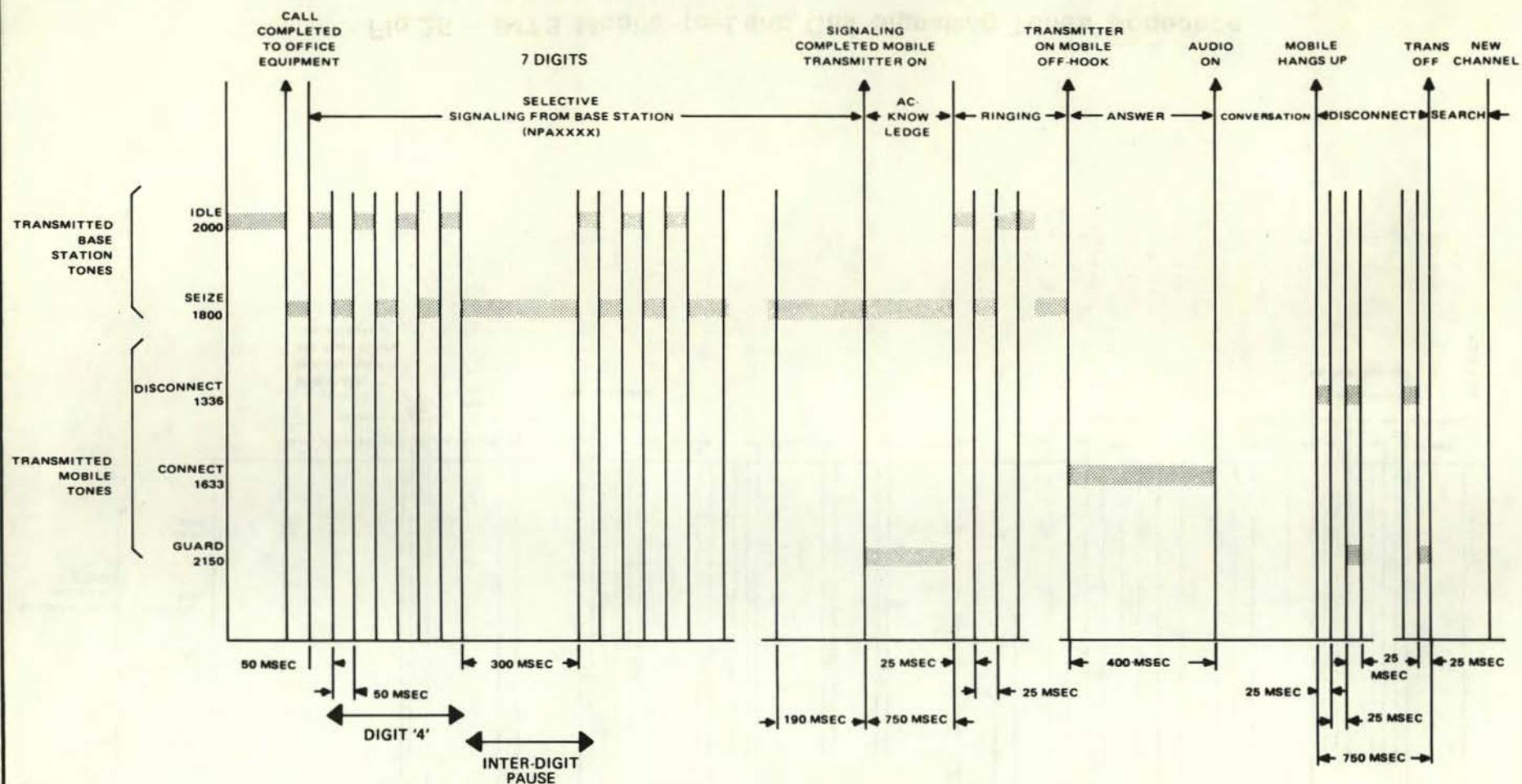


Fig. 24 – IMTS Land-to-Mobile Call Signalling Tones Sequence

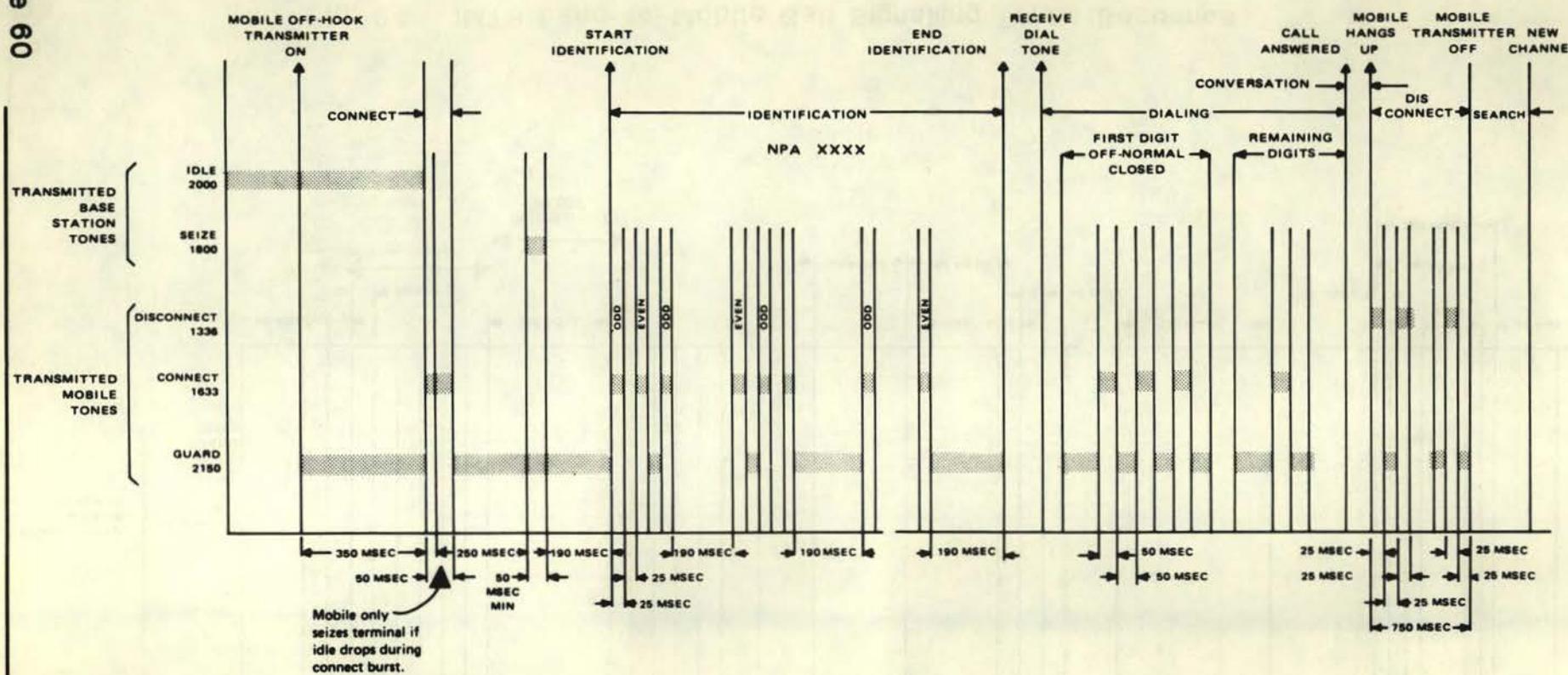
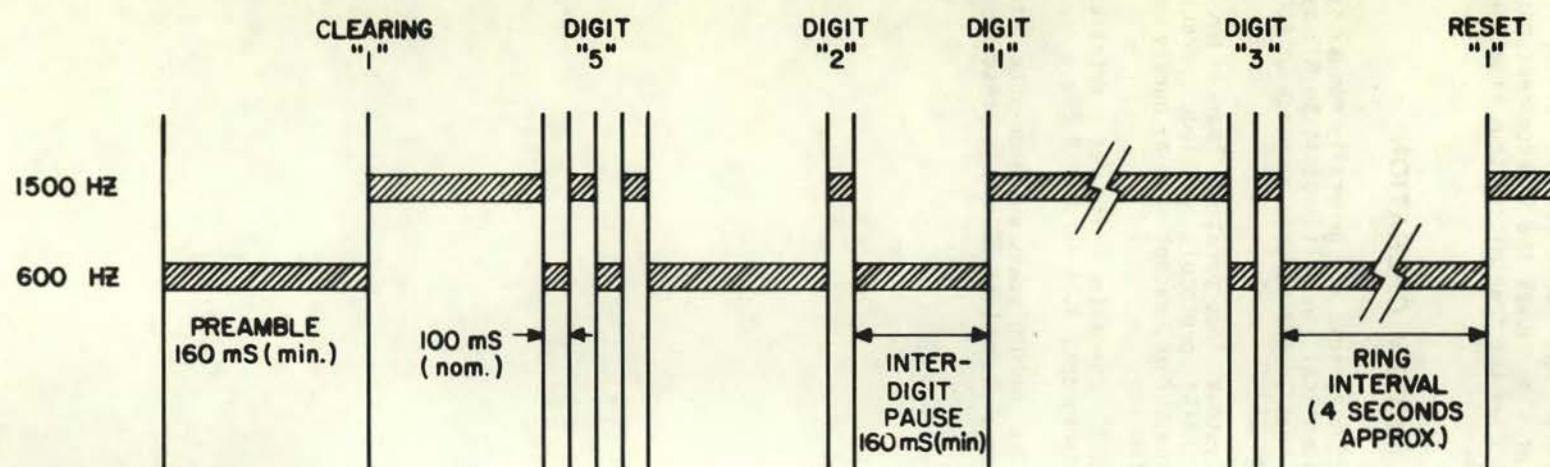
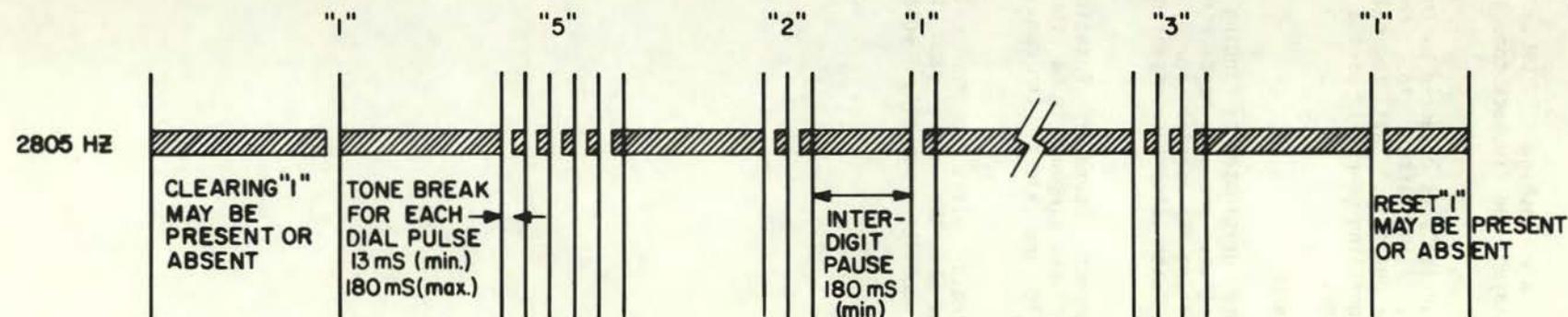


Fig.25 – IMTS Mobile-to-Land Call Signalling Tones Sequence



MTS (600/1500) SIGNALING



2805HZ INTERRUPTED SIGNALING

Fig. 26 – MTS and 2805 Signalling Chart

programmed number a flashing [CALL] indication is displayed and ringback tone is heard on the speaker.

4.18 Presence of "carrier", as detected by the base station, indicates to the interconnect operator position, that the call is answered. MTS signalling generally uses a 5 digit numbering scheme.

Mobile to Land Calls

4.19 Mobile calls are originated by finding a free channel (i.e. one with no carrier present) and transmitting "RF Carrier" for 2, 3 or 4 seconds (varies with telephone company or RCC).

4.20 The Interconnect Operator Position detects this, causes ringback to be sent to the calling mobile and alerts the mobile operator.

4.21 When the operator picks up the call ringback stops and the audio path is connected. The mobile manually voice

identifies and the operator manually dials the requested telephone number.

4.22 On completion of the call the mobile hangs up. Absence of carrier for a period of time causes the interconnect position to shut down the transmitter thus resetting the channel.

2805 SYSTEM OPERATION

4.23 2805 systems are generally manual systems identical in all aspects to MTS systems except that 2805Hz is used in place of 600/1500 Hz (Fig. 26).

Note: Systems incorporating "marked busy" or "SMART" protocols preclude operation of the GL2020, except in a purely manual fashion.

4.24 All operation is as detailed in paragraphs 4.14 through 4.22.

Note: The GL2020 scans while on-hook, stopping on a channel if 2805Hz is present.

Maintenance/
Troubleshooting

Chapter 5

Maintenance and Troubleshooting

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5. MAINTENANCE AND TROUBLESHOOTING

GENERAL

5.01 The GL2020 radiotelephone control head is an ultra compact unit incorporating sophisticated state of the art circuit electronics. These include thick film hybrid circuitry, microprocessor control and LED opto-electronics. Service technicians must be familiar with the special precautions and handling considerations outlined in chapter 2 prior to attempting to service this product.

SERVICE PHILOSOPHY

5.02 The service technician should be familiar with the vehicle installation and the particular radio telephone system in which it is commonly used. Most problems are caused by incorrect cabling, incorrect radio modifications, or "plain old finger trouble" - incorrect programming or operation.

5.03 The intent of the maintenance and troubleshooting guide is to enable the technician to identify problems to the radio or the control head. Difficulties relating to levels, programming etc. will be readily apparent.

***** CAUTION *****

Problems involving failures within the control head proper will normally require factory service. Unauthorized repairs will void standard factory warranty.

Under no circumstances are hybrid circuits to be unsoldered or replaced except under direct factory supervision.

5.04 Technical assistance is available by calling:

or (206) 676-1980
 (604) 980-6041

Ask for Customer Service - Control Heads.

SPECIAL CONSIDERATIONS

5.05 Special reference should be made to Fig.2 for procedures outlining physical access to the GL2020 circuitry.

CMOS Device Handling Precautions

5.06 CMOS integrated circuits have characteristics which make them susceptible to damage or destruction from

electrostatic discharges. High gate input impedances, in spite of built in protection, can result in damage when subjected to fast transient static voltages. Manufacturers and volume users of these devices have developed exotic equipment and handling procedures to eliminate difficulties in this area. Generally, however, the following common sense rules will minimize problems:

- (1) Never use styrofoam blocks, clear plastic bags or containers for storing CMOS integrated circuits.
- (2) Keep CMOS devices in their original conductive shipping packaging until you are ready to utilize them.
- (3) Never remove or insert CMOS integrated circuits, or printed circuit cards containing CMOS, in or out of circuit with power applied.
- (4) Use a proper insertion or removal tool if possible.
- (5) Always use a grounded tip soldering iron.
- (6) Avoid working with equipment containing CMOS devices in high static areas.
- (7) Avoid handling the devices except by holding them by the ends and not touching the metal leads.

ROUTINE MAINTENANCE

5.07 The GL2020 has an inherent design life in excess of fifteen years. Reasonable care and routine checks will ensure that reliable, trouble free operation will be maintained.

The following procedures are recommended:

- (a) Once a year have the system checked by a licensed technician. This is an FCC requirement.
- (b) Check all electrical connections for tightness and ensure no corrosion is evident, especially at the vehicle battery terminals.
- (c) Maintain the vehicle electrical system. Ensure that supply voltages exceeding 16 volts are avoided. These will affect both radio and control head life.
- (d) Clean the control head and handset regularly. Avoid chemical cleaners. Use a soft cloth and a weak solution of household detergent.

- (e) Replace the internal battery every 5 years or so (see paragraph 6.20).

TROUBLESHOOTING

5.08 The following Table provides an outline of the most commonly encountered faults, plus corrective procedures.

NO.	SYMPTOM	PROBABLE CAUSE	REMEDY
1	UNIT WILL NOT TURN ON.	a) Low vehicle battery voltage. b) Control head is locked. c) Main power fuses to radio open. d) Control head fuse open. e) Control cables disconnected.	Charge vehicle battery. Refer to paragraph 3.25 for unlocking procedure. Check fuses and replace if necessary. Check fuse on Interface module. Consult Fig. 34. Check and reconnect cables.
2	(SERVICE) APPEARS ON THE DISPLAY.	a) Unit deprogrammed.	Refer to technician programming (Chapter 2) and reprogram. Verify battery voltage across B301 on the Power and Control module, with the Unit disconnected from the radio. Should be 2.5 - 3.0VDC. Replace battery if necessary. (Consult Pg. 84).
3	UNIT WILL NOT LOCK ON "MARK IDLE".	a) Unit not in IMTS mode. b) No (or low) audio to tone detectors. c) Noisy audio.	Use (M) (A) to review the current area. Ensure IMTS is allowed and correct channels programmed. Check with scope that audio is present at TP401 on the Interface module (at least 50mV p-p). Adjust VOL or RX LEVEL as reqd. Audio input should be observed with better than 10dB signal to noise ratio, although the tone detector will operate down to 4dBS/N. Possible A+ or vehicle battery ripple superimposed on audio. Check cable routing for adequate audio.
4	UNIT PLACES CALLS , BUT FAILS TO DECODE.	a) Incorrect ANI programming or wrong area/ANI selected.	Verify proper area selected. Enter Tech mode and review ANI for selected area.
5	UNIT DOES NOT DETECT DIAL TONE.	a) Wrong dial tone frequency programmed. b) Low audio level.	Enter Tech mode and review (M) (0) - should be dial tone frequency (normally 440Hz). Occassionally in fringe areas "mark idle" will be detected but dial tone being lower in frequency will not. This is due to frequency response rolloff.
6	UNIT ABORTS WHEN SEND KEY IS PRESSED. TRANSMITTER DOES NOT COME ON.	a) Ignition enable feature programmed and ignition key off (or ignition input fuse blown). b) Incorrect operation.	Turn ignition key on (or replace fuse). You must have entered a phone number, or selected a stored phone number, before the Unit will place a call On Hook.

Table 9 - Troubleshooting Guide

NO.	SYMPTOM	PROBABLE CAUSE	REMEDY
7	DURING CHANNEL SEIZURE ATTEMPT UNIT ABORTS AFTER THE TRANSMITTER HAS BEEN ON FOR APPROX 1/2 SECONDS.	<ul style="list-style-type: none"> a) Another mobile seized the terminal before your attempt. b) Transmitter current surge causes power reset. c) Inadequate transmitter tone deviation. d) Transmitter or antenna defective. e) Duplexer defective. f) Terminal out of spec. 	<p>Unit retries automatically.</p> <p>Ensure power connections to radio are secure. Monitor voltage at radio. Vdrop should be no more than 1.5V on transmit key.</p> <p>Using monitor verify tone deviation from transmitter of 3.0 to 4.5 kC.</p> <p>Using SWR and power meter verify proper RF output.</p> <p>Check receiver for desense during transmission.</p> <p>It is possible that the terminal employs receiver voting, mux links or tone control, which could cause the receiver audio to the terminal to be missing the first part of the mobile transmission. Consult the factory if problems of this sort are suspected.</p>
8	UNIT DOES NOT GET DIAL TONE (ROUTED TO OPERATOR OR FAST BUSY).	<ul style="list-style-type: none"> a) Invalid ANI programmed. b) Transmitter tone deviation low. This could result in errors in the ANI being detected by the terminal. 	<p>Check the ANI number is valid with the telephone company or RCC.</p> <p>Verify using communications monitor that TX tone deviation is 3.0 to 4.5 kC.</p>
9	TRANSMITTER (TX LIGHT) FLASHES ON VERY BRIEFLY DURING CALL ATTEMPT UNIT SHUTS OFF.	<ul style="list-style-type: none"> a) Heavy transmitter current causes control head voltage to fall below 9.8V. 	Check all power connections.
10	NO RECEIVE AUDIO (SPEAKER AND HANDSET).	<ul style="list-style-type: none"> a) Volume control (F) (2) set for very low output. 	In operating mode use (F) (1) to raise speaker to comfortable level. If inoperative or no effect : Verify RX audio present across R406 on Interface module. (If not present verify audio present at TP401 on Interface module - consult factory if not present).
11	NO RECEIVE AUDIO (HANDSET ONLY).	<ul style="list-style-type: none"> a) Handset or cord defective, or unplugged. 	Replace as required.

Table 9 (cont'd)

REMEDY	PROBABLE CAUSE	SYMPTOM	Q.
On the basis of information from the FBI, it is recommended that the FBI and the FBI Laboratory conduct a comparison of the handwriting sample taken from the envelope and the handwriting sample taken from the letter sent to Mrs. [redacted] on April 21, 1968.	The handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Q. 1 GUNSHOT WOUNDS CAUSED BY A GUNSHOT FROM AN ASSAULT RIFLE OR AUTOMATIC RIFLE WHICH WAS FIRED FROM A DISTANCE OF APPROXIMATELY 10 FEET.
On the basis of information from the FBI, it is recommended that the FBI and the FBI Laboratory conduct a comparison of the handwriting sample taken from the envelope and the handwriting sample taken from the letter sent to Mrs. [redacted] on April 21, 1968.	The handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Q. 2 GUNSHOT WOUNDS CAUSED BY A GUNSHOT FROM AN ASSAULT RIFLE OR AUTOMATIC RIFLE WHICH WAS FIRED FROM A DISTANCE OF APPROXIMATELY 10 FEET.
On the basis of information from the FBI, it is recommended that the FBI and the FBI Laboratory conduct a comparison of the handwriting sample taken from the envelope and the handwriting sample taken from the letter sent to Mrs. [redacted] on April 21, 1968.	The handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Q. 3 GUNSHOT WOUNDS CAUSED BY A GUNSHOT FROM AN ASSAULT RIFLE OR AUTOMATIC RIFLE WHICH WAS FIRED FROM A DISTANCE OF APPROXIMATELY 10 FEET.
On the basis of information from the FBI, it is recommended that the FBI and the FBI Laboratory conduct a comparison of the handwriting sample taken from the envelope and the handwriting sample taken from the letter sent to Mrs. [redacted] on April 21, 1968.	The handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Q. 4 GUNSHOT WOUNDS CAUSED BY A GUNSHOT FROM AN ASSAULT RIFLE OR AUTOMATIC RIFLE WHICH WAS FIRED FROM A DISTANCE OF APPROXIMATELY 10 FEET.
On the basis of information from the FBI, it is recommended that the FBI and the FBI Laboratory conduct a comparison of the handwriting sample taken from the envelope and the handwriting sample taken from the letter sent to Mrs. [redacted] on April 21, 1968.	The handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Handwriting sample taken from the envelope was taken from a white envelope which contained a white card with the following address:	Q. 5 GUNSHOT WOUNDS CAUSED BY A GUNSHOT FROM AN ASSAULT RIFLE OR AUTOMATIC RIFLE WHICH WAS FIRED FROM A DISTANCE OF APPROXIMATELY 10 FEET.

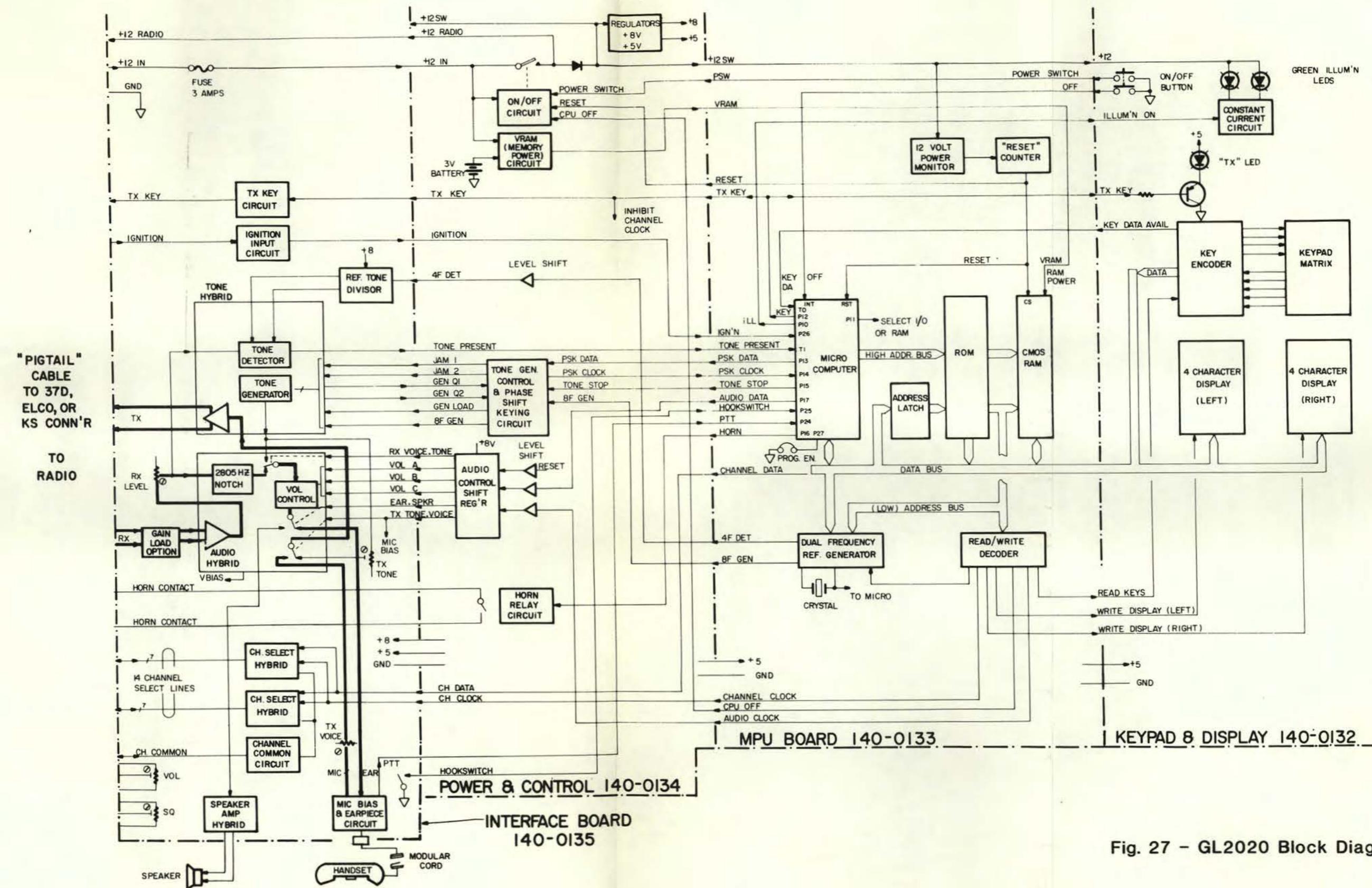
Page 8 (cont'd)

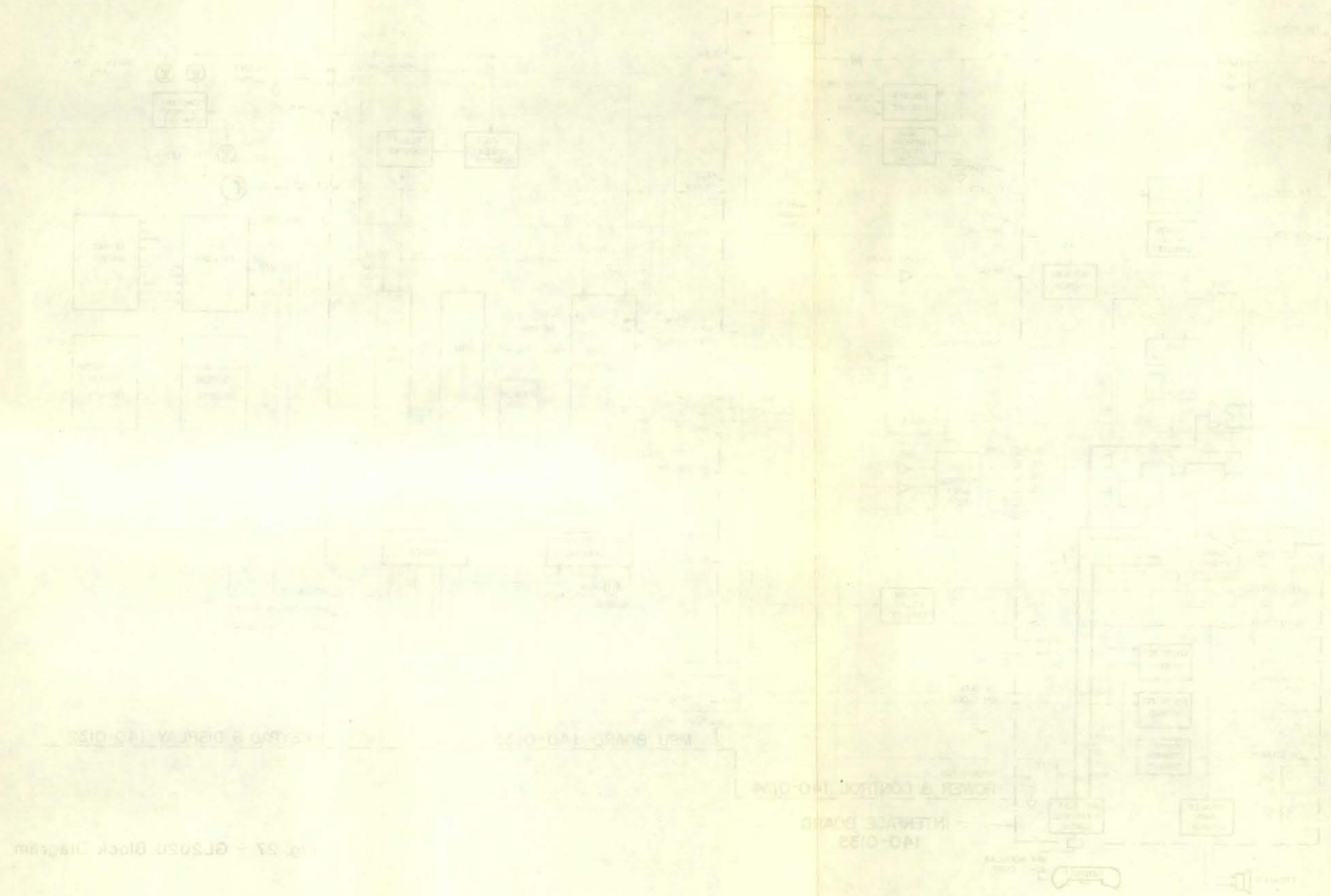
NO.	SYMPTOM	PROBABLE CAUSE	REMEDY
12	POOR TX AUDIO	<ul style="list-style-type: none"> a) Incorrect deviation setting. b) Faulty microphone. c) Mic bias circuitry defective. 	<p>Tone deviation and voice deviation should be in range 3.0 to 4.5kC.</p> <p>Replace as required.</p> <p>Using scope, verify level across C402 to be in range 1 - 2.5Vp-p when speaking into microphone. Ranges below this indicate faulty circuitry.</p>
13	UNIT SELECTS WRONG CHANNEL	<ul style="list-style-type: none"> a) Memory 7 programming in error. b) Control cable wiring incorrect. c) Radio crystals are installed in a non standard order. 	<p>Check Radio Interface drawing for correct (M) (7) programming.</p> <p>Check Radio Interface drawing for cable information.</p> <p>Correct crystal. (Note: The "wrong" channel may be perfectly acceptable to the user if the areas are programmed accordingly.)</p>

Table 9 (cont'd)

ITEM	POTENTIAL SOURCE	SOURCE	COMPOUND	OK
1.0 C atoms in C ₆ H ₅ Cl ₂ may have been derived from C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	100% X Yield
1.0 C atoms in C ₆ H ₅ Cl ₂ may have been derived from C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	C ₆ H ₅ Cl ₂ which was synthesized by the reduction of C ₆ H ₅ Cl ₂ with zinc dust and dilute HCl.	100% X Yield

(b)(6) (c)(4)





Detailed
Circuit Theory

Chapter 6

Detailed Circuit Theory

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Chapter 6

Desired Circuit Theory

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35	B. T.E. Waves
48	C. Power and Current Waves
58	D. Impedance, Load
68	E. Power Gain
74	F. Quality Caps

6. DETAILED CIRCUIT THEORY

GENERAL DESCRIPTION

6.01 The Unit contains four circuit modules which interconnect as shown in Fig. 27. The general function of each of the modules is as follows:

Keypad and Display Module

- on/off key, five "function" keys and a 12 button telephone keypad
- green LED key illumination
- key encoder chip
- eight character alphanumeric display
- TX LED and driver

MPU Module

- microcomputer, with 4K x 8 program memory and 256 x 8 CMOS RAM memory
- crystal oscillator
- dual tone reference generator
- power-on-reset circuit
- read/write I/O control

Power and Control Module

- on/off magnetic latching relay and drive, with CMOS flip flop control
- voltage regulators for 5V and 8V DC
- VRAM power supply, to maintain RAM memory contents, with three volt Lithium battery
- tone generator control circuit
- audio control circuit
- horn relay circuit

Interface Module

- TX key circuit
- ignition input circuit
- "Tone" hybrid for tone generation/detection
- "Audio" hybrid for 2805 Hz notch filter, audio switching, and electronic volume control
- up to 14 channel select lines
- "Speaker Amp" hybrid
- microphone bias
- input power fuse
- hookswitch

MODULE DESCRIPTIONS

6.02 Each module will be discussed in depth in the following paragraphs. Schematic and Card Assembly drawings for each module have been provided as well as Parts Lists.

A. Keypad and Display Module (Assy #140-0132)

Keypad Illumination (U101,Q101)

6.03 Behind each of the 18 keys is a green LED (D102 through D119). The LEDs are driven by constant current source U101, connected as a "current mirror", so that each LED has a constant current of approximately 3 mA regardless of voltage fluctuations of the vehicle +12V input. The LEDs can be switched on and off by the computer via Q101 (the ILLUM signal is taken to +5V to turn the LEDs on). The LEDs are on at all times, except when the Unit is "locked".

Keypad Encoder (U102)

6.04 U102 is a CMOS Key Encoder, which detects when any key is pressed, "debounces" the key, and signals the computer by putting signal KEYDA (Key Data Available) high. Subsequently, the computer takes signal RKEY ('Read Key') low, which forces U102 to put a five bit binary code on the data bus, the code corresponding to the key. The encoder features "2 key rollover" so that if a second key is pressed before the first is released, both keys are detected correctly.

Display (U103, 104)

6.05 The eight character display is formed from two four character Litronix DL 1414 displays (U103 and U104). The character displayed has full ASCII alphanumeric capability. The display memory is loaded by the computer by putting the seven bit character code onto the data bus, selecting one of the four character position by means of signals A0 and A1, and strobing the circuit with a WDL or WDR (Write Display Left or Right) low going pulse.

Tx Key Circuit (Q102)

6.06 The red TX LED indicator D101 is turned on and off by the computer, using Q102 and the TX KEY signal (low to turn the LED on).

On/Off Key

6.07 The On/Off key has two contacts. One goes to the Power and Control board, the other to the microcomputer on the MPU board.

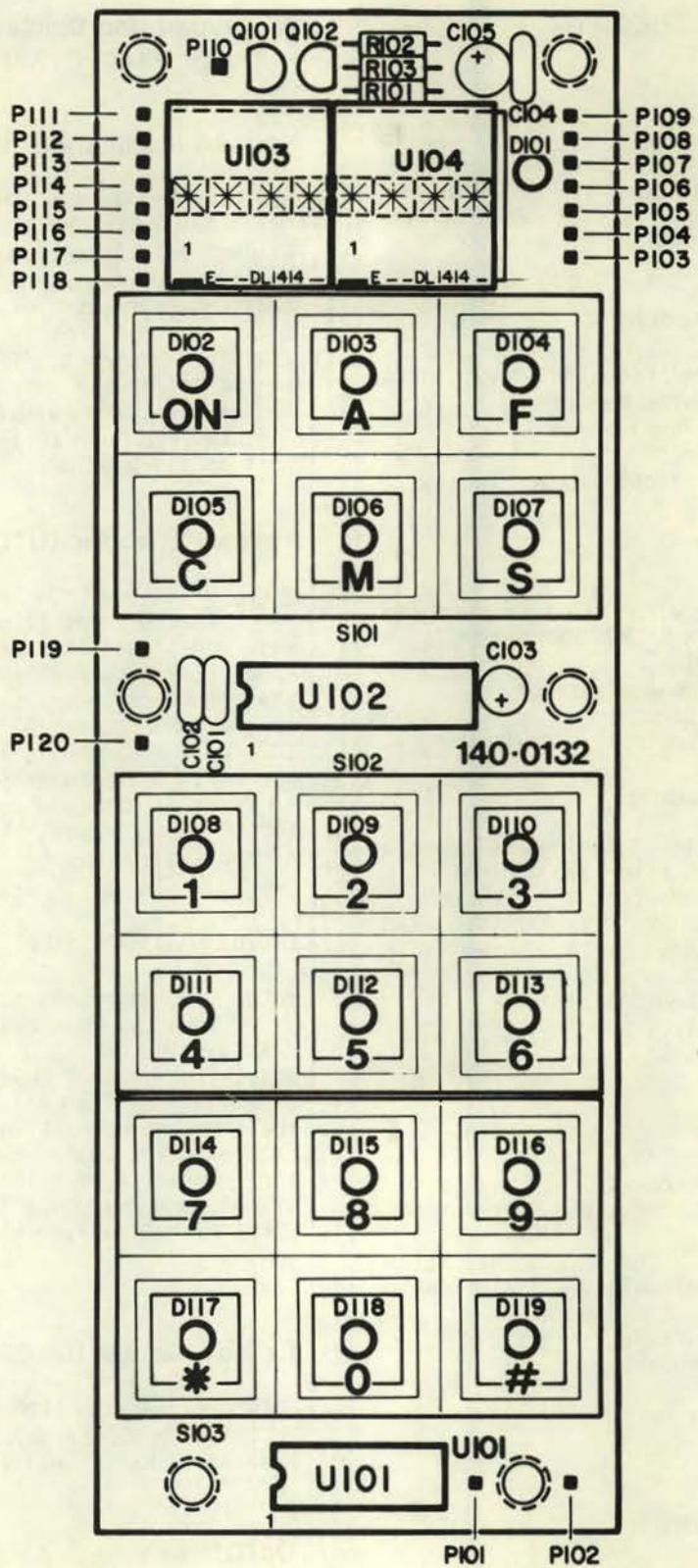


Fig. 28 - Keypad and Display Module - Card Assembly

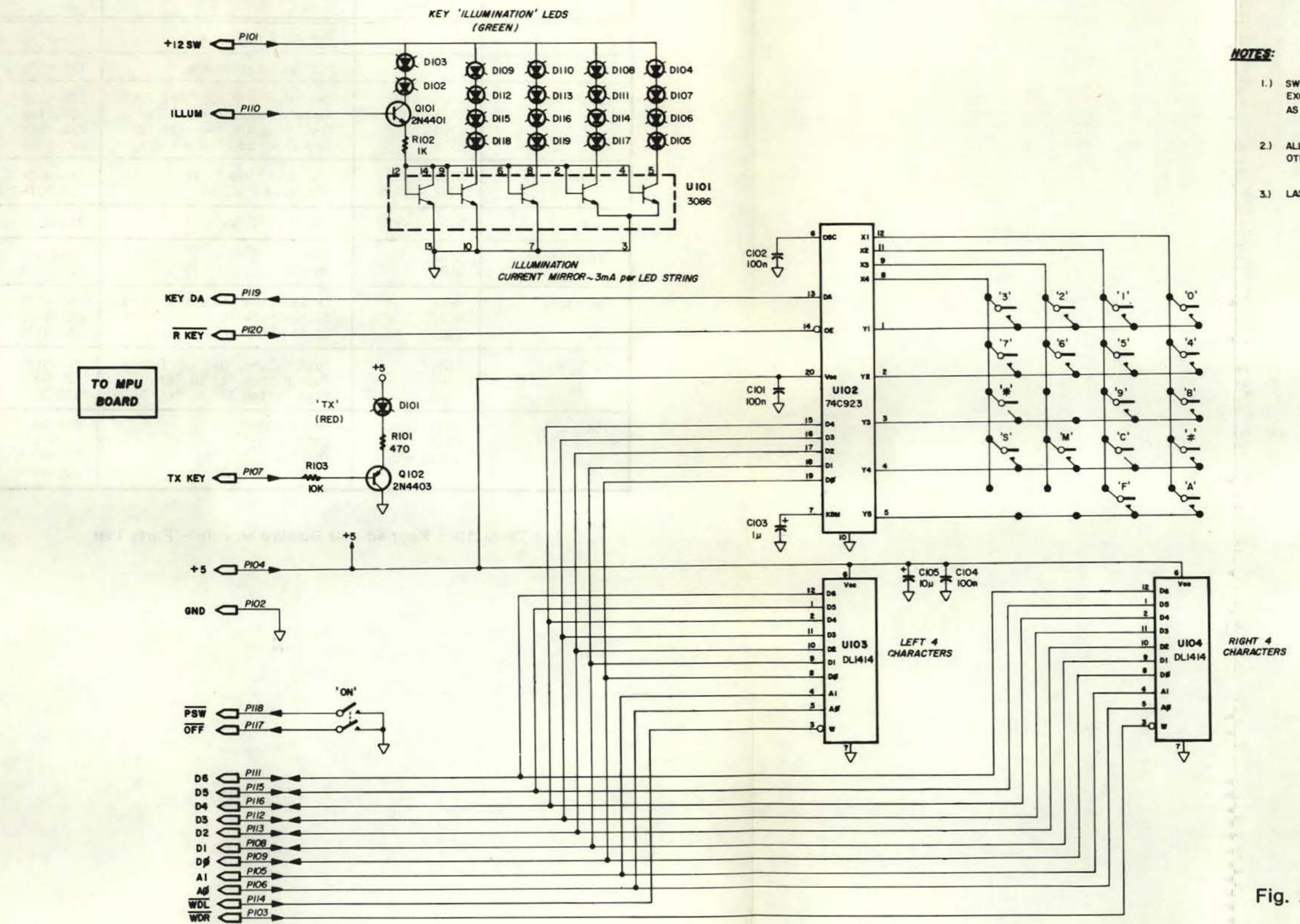


Fig. 29 - Keypad and Display Module Schematic Diagram

Part Type	Circuit Reference	Description	GL Part No.
Module	-	PCB Assy complete	140-0132
Board	-	PCB less components	137-0172
Capacitors	C101, C102 C103 C104 C105	Cer. Mono X7R 100n 50V 10% Tantalum rad. 1u 35V 20% Cer. Mono X7R 100n 50V 10% Tantalum rad. 10u 35V 20%	286-1037 280-5102 286-1037 280-5108
Diodes	D101 D102 - D119	LED, red LD30 I, T1 LED, green SG205D	235-0004 235-0015
Pins	P101 - P120	Pin .025 Sq WW	313-0026
Transistors	Q101 Q102	2N4401 2N4403	201-0007 201-0008
Resistors	R101 R102 R103	Carbon Film 470 ohm 1/4W 5% Carbon Film 1K 1/4W 5% Carbon Film 10K 1/4W 5%	261-0078 261-0086 261-0110
Switches	S101 S102 S103	Push button 'ON' to 'SD' Push button '1' to '6' Push button '7' to '#'	328-0089 328-0090 328-0091
ICs	U101 U102 U103, U104 -	Linear 3086 CMOS 74C923 Display - DL1414 Socket - DIP 28	238-9007 242-0117 337-0004 305-0034

Table 10 - Keypad and Display Module - Parts List

B. MPU Module (Assy #140-0133)**Microcomputer (U208)**

6.08 A CMOS 80C35 microcomputer U208 controls the unit. This device features 27 I/O lines, an internal timer, and 64 bytes of RAM. Its detailed operation is outside the scope of this document. The device is clocked by a 4.608 MHz clock, crystal driven by Y201, resulting in an ALE frequency of 307.2 KHz. Port bits are assigned as shown in Table 11.

Program Memory (U206)

6.09 The computer fetches instructions from the Program Memory resident in U206 (a 4Kbyte memory chip), by:

- (a) latching the low order eight address bits into U207, an octal latch, with the ALE pulse.
- (b) setting up the four high order address bits on port 2.
- (c) generating a low PSEN pulse.

The instruction is then read from the data bus. Jumpers JR201 through 204 allow different types of ROM to be used for program memory.

Scratchpad Memory (U204, 205)

6.10 The unit has 256 bytes of CMOS Random Access Memory (RAM) in U204 and U205 (plus 64 bytes of internal RAM in the microcomputer).

6.11 The RAM is read or written using the RD or WR signals from the MPU, in conjunction with port bit P11. If P11 is low, the RAM is selected. When P11 is high, transistor Q201 turns on to select external I/O chip U202 instead of RAM. The RAM contents are maintained when the unit is switched off, via the vehicle battery or internal battery which feed the VRAM "5" volt supply (this circuit is on the Power and Control module).

External I/O (U202)

6.12 U202 is a dual decoder which, when enabled by P11, as described above, produces one of four possible Read pulses, or one of four possible Write pulses, assigned as shown in Table 12.

#	Read	Write
0	READ KEY	WRITE DISPLAY RIGHT
1	AUDIO CLOCK	WRITE DISPLAY LEFT
2	NOT USED	STROBE U209 TONE REF
3	CPU OFF	CHANNEL CLOCK

Table 12 - External I/O Read/Write Pulses

Each of these pulses is a brief low going pulse when the MPU accesses external memory with port bit P11 high.

Note: The AUDIO CLOCK AND CPU OFF signals use pseudo READ instructions, even though they are actually output functions.

Bit	Port 0	Port 1	Port 2
0	Data Bus	ILLUM (OUT)	PROM ADDRESS
1	Data Bus	SELECT I/O (OUT)	PROM ADDRESS
2	Data Bus	TX KEY (OUT)*	PROM ADDRESS
3	Data Bus	PSK DATA (OUT)	PROM ADDRESS
4	Data Bus	PSK CLOCK (IN)	PTT (IN)*
5	Data Bus	TONE STOP (OUT)	HKS W (IN)*
6	Data Bus	HORN (OUT)*	IGN'N (IN)*
7	Data Bus	AUDIO DATA (OUT)	ENABLE (IN)*

Table 11 : MPU Module – Port Bits Assignment

Notes: * Indicates active low

Other I/O bits are: T1 TONE PRESENT (IN), active low
 T2 KEY DATA AVAILABLE (IN)
 INT ON/OFF BUTTON (IN), active low

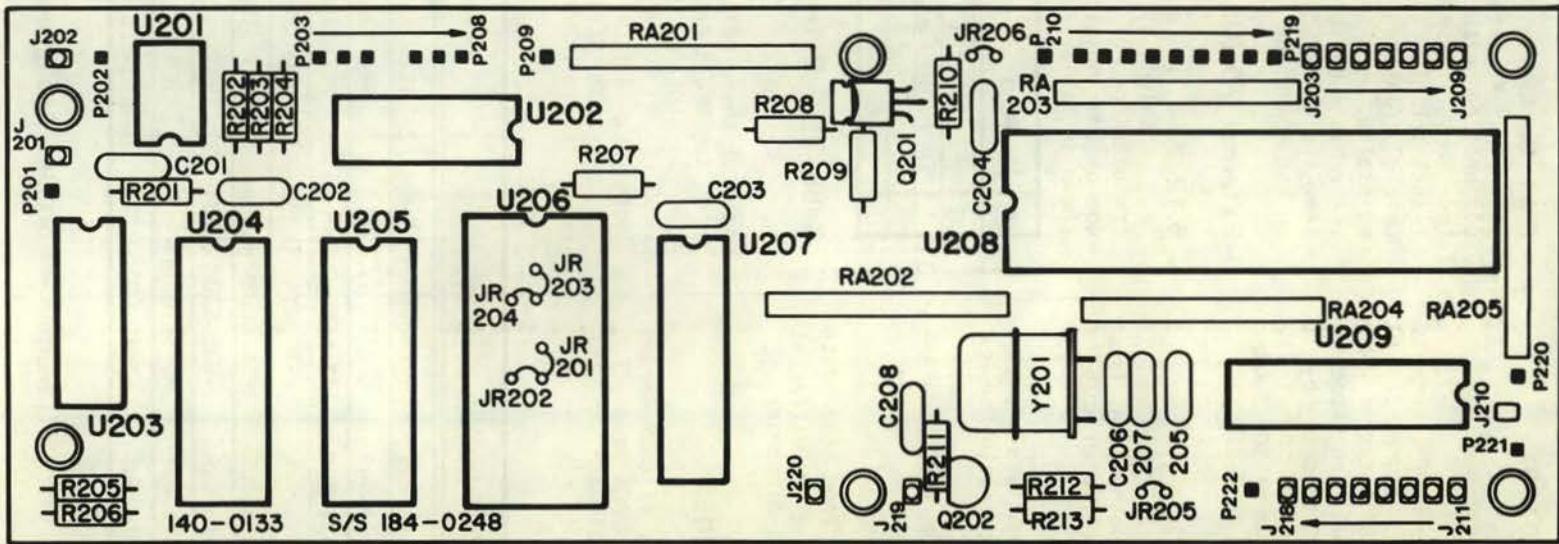
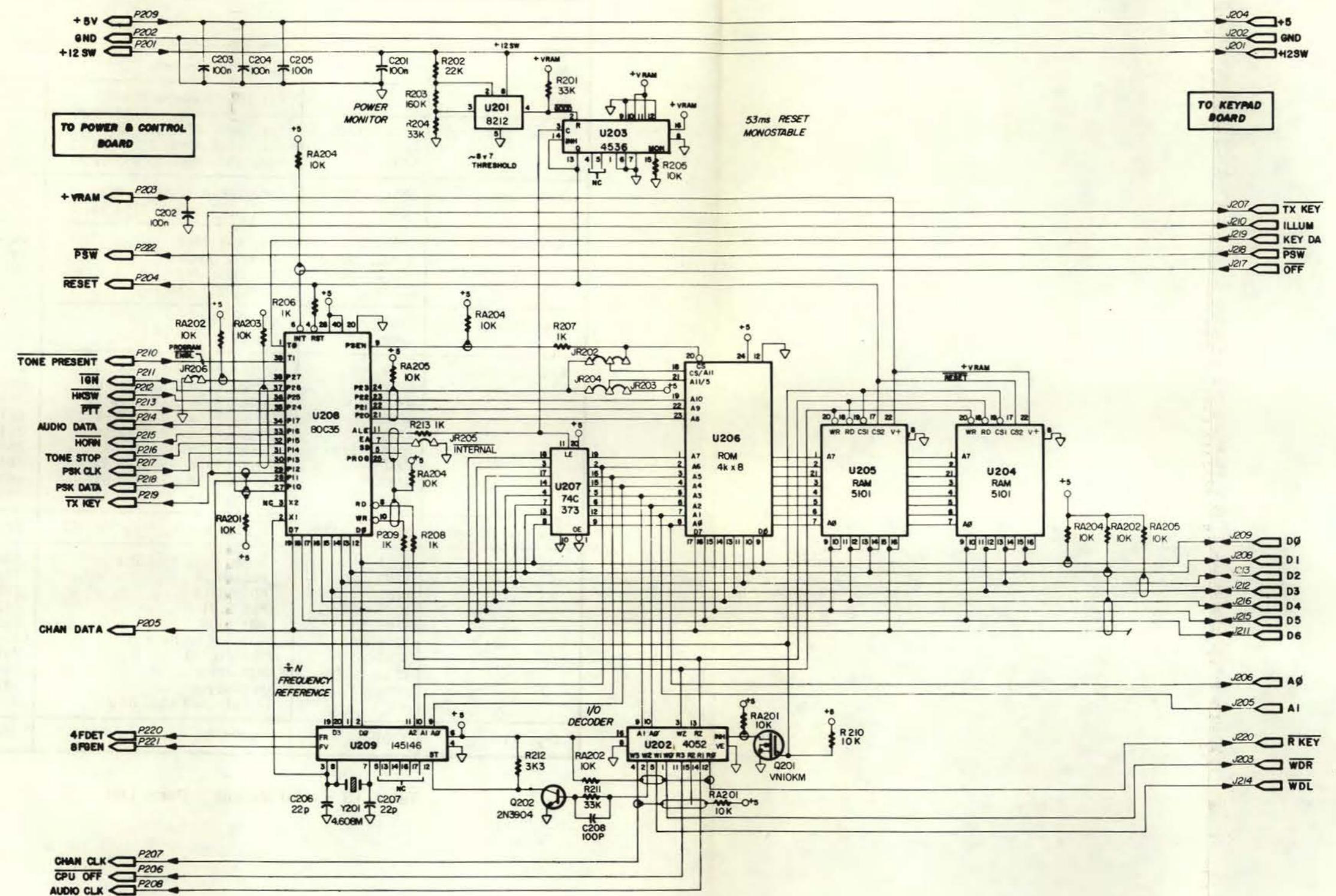


Fig. 30 – MPU Module – Card Assembly



NOTES:

- 1) ROM STRAPPING
CM3200 JR202, JR203
2532 JR202, JR203
2732 JR201, JR204
2716 JR201, JR203
NB: JR2, JR3 ARE ARTWORKED JUMPERS.
 - 2) PROGRAM ENABLE
JUMPER JR206 MUST BE INSTALLED TO ALLOW TECHNICIAN PROGRAMMING
 - 3) INTERNAL ACCESS
JUMPER JR205, WHEN FITTED, ENABLES FETCHING OF PROGRAM CODE FROM INTERNAL 8048 MEMORY (NOT NORMALLY FITTED.)
 - 4) U206 CONTAINS THE PROGRAM CODE AND MAY VARY WITH APPLICATION.
 - 5) R206, 207, 208, 209, 213 ARE FOR TEST PURPOSES ONLY.
 - 6) ALL RESISTORS ARE 1/4W 5% UNLESS OTHERWISE SPECIFIED.
 - 7) LAST USED DESIGNATIONS

R213
RA205
C208
Q202
U209
Y201
J220
P222
JR206

Fig. 31 – MPU Module Schematic Diagram

Part Type	Circuit Reference	Description	GL Part No.
Module	-	PCB Assy complete	140-0133
Board	-	PCB less components	137-0173
Capacitors	C201 - C205 C206, C207 C208	Cer. mono X7R 100n 50V 10% Cer. plat N1500 22p 100V 2% Cer. plat N750 100p 100V 2%	286-1037 284-2192 284-2184
Connectors	J201 - J220 P201 - P222	Receptacle, .025 post Pin, .025 Sq. WW .750 lg.	308-9012 313-0070
Jumpers	JR201 JR202, JR203 JR204, JR205 JR206	Not installed Artwork jumper Not installed Formed 0.1 spacing	499-0001 499-0010 499-0001 270-0011
Transistors	Q201 Q202	VN10KM FET 2N3904	201-0044 201-0005
Resistors	R201 R202 R203 R204 R205 R206 - R209 R210 R211 R212	Carbon Film 33K 1/4W 5% Carbon Film 22K 1/4W 5% Carbon Film 160K 1/4W 5% Carbon Film 33K 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 1K 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 33K 1/4W 5% Carbon Film 3K3 1/4W 5%	261-0122 261-0118 261-0139 261-0122 261-0110 261-0086 261-0110 261-0112 261-0098
Resistor Network	RA201 - RA205	10 pin, 9 res, SIP, 10K 10%	276-0133
ICs	U201 U202 U203 U204 U205 U206 U207 U208 U209 -	Linear 8212 Mini Dip CMOS 4052B CMOS 4536B CMOS 5101 CMOS 5101 2532 ROM or Mask ROM CMOS 74C373 CMOS 80C35 CMOS 45146 Socket .040 mtg. hole	238-9013 242-0120 242-0139 242-0046 242-0046 499-0006 242-0048 242-0138 242-0129 305-0202
Crystal	Y201	4.6080 MHz, HC-18/U	302-0007

Table 13 - MPU Module - Parts List

Tone Reference (U209)

6.13 U209 is a dual "divide by N" counter, which produces two pulse trains:

- 4FDET, a pulse train at four times the desired tone detection frequency.
- 8FGEN, a pulse train at eight times the desired generated tone frequency.

U209 features an internal 10 bit counter for 8FGEN, and a 12 bit counter for 4FDET. The counters are selected using A0, A1, and A2 inputs. The N bit divisors are loaded in four bit "nibbles" from the data bus. The counters are clocked by the 4.608 MHz oscillator, resulting in a lowest tone detection frequency of $4.608M/(4095 \times 4) = 281.32$ Hz, and a lowest tone generation frequency of $4.608M/(1023 \times 8) = 563.05$ Hz.

Reset Circuit (U201, 203)

6.14 U201 is an Intersil 8212 precision voltage monitor circuit whose output (pin 4) is low if the "+12 SW" voltage exceeds 7.5V. Once it does, hysteresis is used to keep the output low until the voltage drops to 6.8V. Due to diode and fuse voltage drops on other boards, the circuit indicates "good" input at approximately 8.5V on the unit's input power lead, dropping out at 7.8V. Counter U208 is used to provide a long (53 mS) reset pulse whenever the power is restored or first turned on. U203 counts ALE pulses, and requires 16,384 of them (14 bits) before U203 pin 13 goes high. Any power drop out, no matter how short, causes U201 output to go high to reset the U203 counter.

Note: U203 is powered by VRAM (battery backup supply) to ensure that the reset circuit operates correctly as power is being applied or removed.

**C. Power and Control Module
(Assy #140-0134)****Power On/Off Circuit**

6.15 Relay K301 is a magnetically latching, dual coil relay, with a heavy duty contact which turns power on and off to the radio and the control head. To operate (set) the relay, VFET transistor Q305 is turned on briefly. To release (reset) K301, Q306 VFET is pulsed on briefly. In this way, power consumption is kept to a minimum, as no power is required to maintain contact closure. The relay is set when the 'PSW' signal from the ON button goes low, producing a brief low signal on the input to U301 gate via C305 capacitor.

6.16 The PSW signal also feeds the reset side of the circuitry, via R302 to the other gate of U301. However, brief pushes of the ON key do not get through, as C301 capacitor does not discharge in time. If the ON key is held down (for about 1 second), however, C301 eventually discharges and resets the relay unconditionally. This provides a valuable safety method of turning the unit off.

6.17 Normally, the unit is turned off by the microcomputer, which senses the OFF signal, debounces it to ensure the key is pressed for 100 mS or more, and produces a CPU OFF low signal. This signal changes the state of the DC flip flop formed by the remaining gates of U301, causing U301 pin 3 to go low to reset the relay. Once power is off, the RESET signal resets the DC flip flop.

Note: U301 is powered by VRAM to ensure correct operation as power is being applied or removed.

VRAM Circuit (Q302, Q303, B301)

6.18 The VRAM ("Voltage to the RAM memory") circuit is required to provide a nominal 5 volt supply at all times to the RAM, the U301 power on/off circuit, and the power-on-reset circuit on the MPU board. When the unit is off, the power drain is very small - in the region of microAmps. Zener diode D304 is fed from the raw unswitched 12 volts input (protected by transient suppressor D305), to produce 5 volts at the cathode of D303, on the VRAM supply. This supply is present while the vehicle battery is connected. Should the vehicle battery get disconnected, the 3 volt Lithium battery B301 provides VRAM power at approximately 2.8 volts via low voltage drop diode D309.

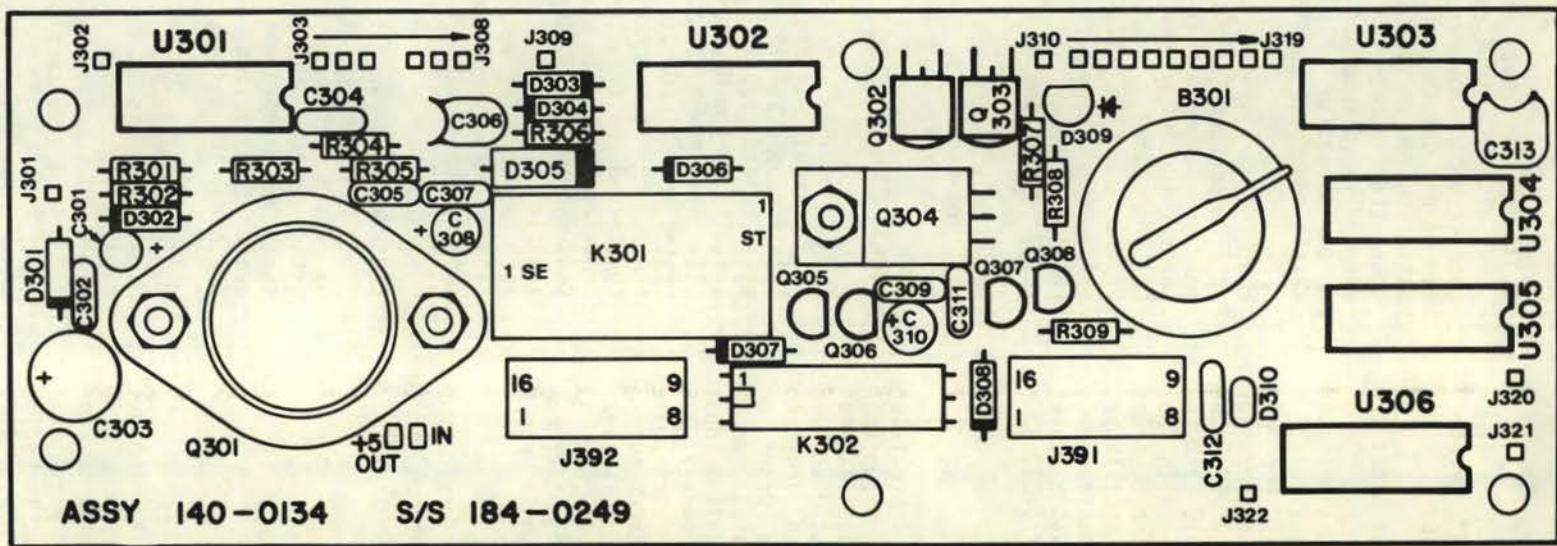
6.19 When the unit is turned on and operating, VRAM is fed via Q303 which is turned on by the 8 volt supply through R307 to its base, with the regulated 5V on its collector. Q302 turns Q303 off whenever there is a RESET, to avoid Q303 acting as a "backward" NPN to discharge the battery.

6.20 The battery is a "Panasonic" BR2325 MML1, which is 3 volts, 150 milliAmp hour capacity, Lithium non-rechargeable type. Lithium batteries have extremely long shelf life (well in excess of five years).

Regulators (Q301, Q304)

6.21 The integrated voltage regulators derive +5V and +8V from the 12 volt switched supply, fed via diode D301. Q301 (5V) is a T03 package, for good heat dissipation. Q304 (8V) features low input-to-output differential, so

Fig.32 - Power and Control Module - Card Assembly



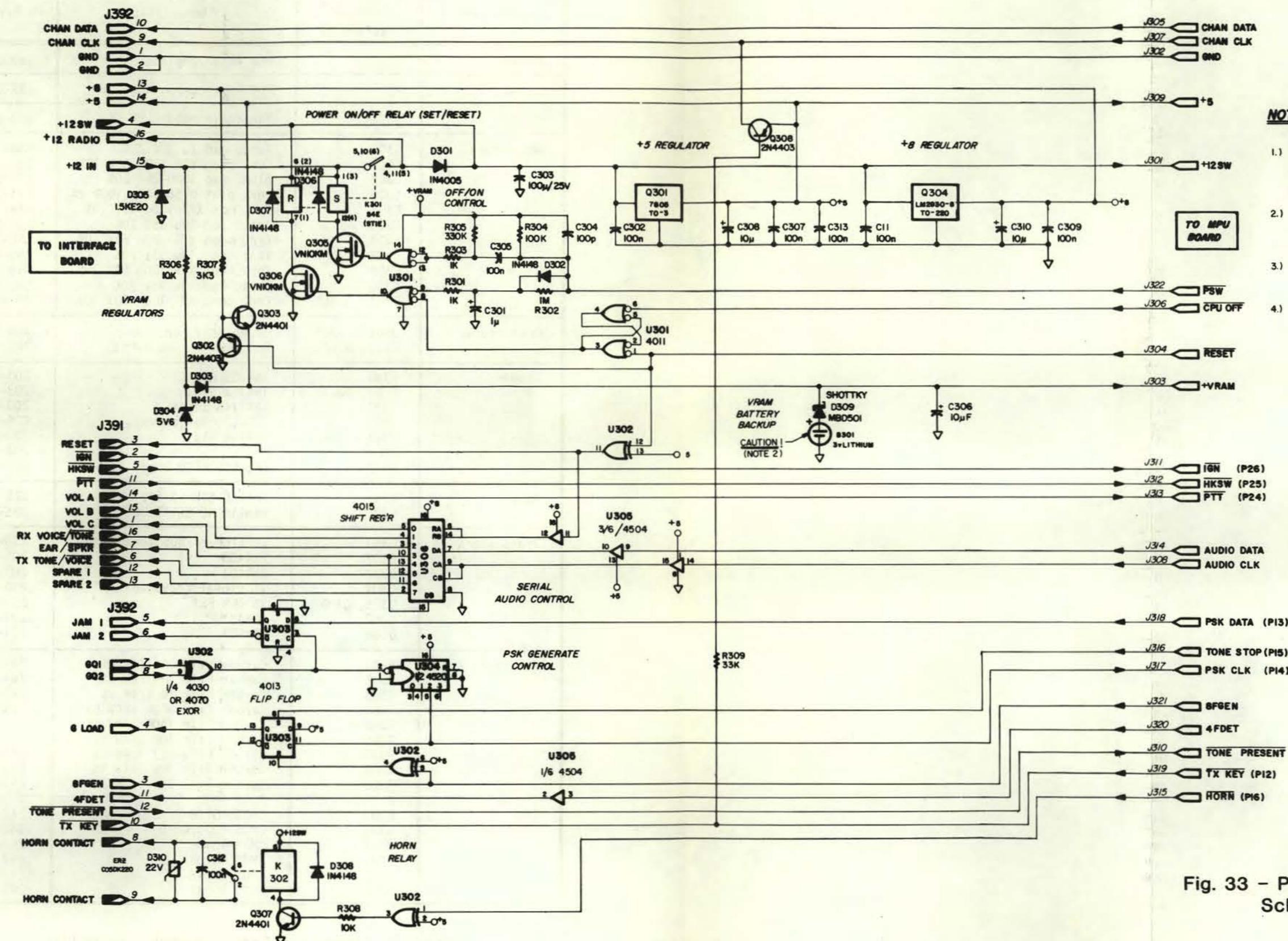


Fig. 33 - Power and Control Module Schematic Diagram

Part Type	Circuit Reference	Description	GL Part No.
Module	-	PCB Assy complete	140-0134
Board	-	PCB less components	137-0174
Battery	B301	Panasonic BR2325 MM L1	303-0009
Capacitors	C301 C302 C303 C304 C305 C306 C307 C308 C309 C310 C311 - C313	Tant. rad 1u 35V 20% Cer. mono-X7R 100n 50V 10% Alum. rad 100u 25V 20% Cer. plat N750 100p 100V 2% Cer. mon X7R 100n 50V 10% Tant. rad 10u 35V 20% Cer. mono X7R 100n 50V 10% Tant. rad 10u 35V 20% Cer. mono X7R 100n 50V 10% Tant. rad 10u 35V 20% Cer. mono X7R 100n 50V 10%	280-5102 286-1037 278-5223 284-2184 286-1037 280-5108 286-1037 280-5108 286-1037 280-5108 286-1037
Connectors	J301 - J322 J391, J392	Receptacle, 025 pin Receptacle, 2x8 horiz.	308-9012 308-9022
Diodes	D301 D302, D303 D304 D305 D306 - D308 D309 D310	1N4005 Rect. 1N4148 Sig. 1N4734A Zener 1.5KE20 Surge Supp. 1N4148 Sig. MBD501 ERZ-C05DK220 Surge Supp.	203-0014 203-0015 203-5036 204-0016 203-0015 203-0039 204-0007
Relays	K301 K302	Aromat SAE-L2-12V Hamlin HE 821A1200	325-0034 325-0035
Transistors	Q301 Q302 Q303 Q304 Q305, Q306 Q307 Q308	IC Linear 7805 T0-3 2N4403 2N4401 IC Linear LM2930-8 VN10KM FET 2N4401 2N4403	238-3008 201-0008 201-0007 238-3016 201-0044 201-0007 201-0008
Resistors	R301 R302 R303 R304 R305 R306 R307 R308 R309	Carbon Film 1K 1/4W 5% Carbon Film 1M 1/4W 5% Carbon Film 1K 1/4W 5% Carbon Film 100K 1/4W 5% Carbon Film 330K 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 3K3 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 33K 1/4W 5%	261-0086 261-0158 261-0086 261-0134 261-0146 261-0110 261-0098 261-0110 261-0122
ICs	U301 U302 U303 U304 U305 U306	CMOS 4011B CMOS 4030/4070 CMOS 4013B CMOS 4520B CMOS 4504B CMOS 4015B	242-0003 242-0022 242-0005 242-0039 242-0114 242-0006

Table 14 - Power and Control Module - Parts List

that regulated 8V is available at low vehicle supply voltage. All logic is driven from +5V. The +8 supply feeds analog circuitry on the Interface board, and analog control circuitry on the Power and Control board.

Audio Control (U305, U306)

6.22 In order for the MPU to turn various audio signals on and off, shift register U306, which is powered by +8V, is fed with serial AUDIO DATA and AUDIO CLOCK from the MPU board, via level shifter gates U305. Thus, whenever any audio control change is required, the MPU shifts eight data bits into U306. It does so rapidly (in less than a few hundred microseconds) to minimize "clicks" in the speaker and earpiece.

6.23 Q308 is fitted to act as a 'safety' device, to disable channel clocks whilst the unit is transmitting.

Tone Generation / PSK Control (U302 – U304)

6.24 For simple continuous tones for IMTS signalling, the MPU feeds 8FGEN reference signal to the Interface board and turns the tone on and off via the TONE STOP signal which presets flip flop U303 (pin 13) output to go high. For Phase Shift Keying (PSK) tones, the MPU must invert the phase of the tone at the zero crossing point, using U303 'JAM' outputs and the PSK CLOCK input for synchronizing purposes. (see 6.30)

Horn Relay Circuit (Q307, K302)

6.25 The MPU can operate the horn relay actuator K302, via U302 gate and transistor Q307. The relay contact is suppressed with D310 and C312.

D. Interface Module

Channel Select (U403, U404, U406)

6.26 U403 and U404 are proprietary Glenayre hybrid circuits, which allow the MPU to load channel selection bits serially using CHAN DATA and CHAN CLOCK signals. The hybrids can interface to any type of radio, with the correct jumper options JR401 through 404, and the correct "attribute" loaded into technician memory (7).

6.27 U406 is a multi-transistor IC connected to provide a voltage swing from ground to +12V, when the channel select lines are used as inputs (as is the case for Motorola T1200 radios, and others).

6.28 The jumper option positions are normally listed on the specific radio interface drawing. Their functions are as follows:

JR401 Install only when the channel select lines are inputs, and the GL 2020 switches the channel common high and low (eg. Motorola "pulse" type control).

JR402 Install when the radio provides positive channel common voltage (eg. Aerotron 600TT).

JR403 Install when the channel select line high voltage is to be pulled to +5V by the GL 2020.

JR404 Install when the channel select line "low" voltage is to be "ground" (eg. most radios).

Tx Key Circuit (Q401, Q403)

6.29 The MPU turns keying VFET transistor Q401 on and off. The VFET has an "ON" resistance of 4 ohms typically, to allow it to drive virtually any load in the radio. A few radios require active high keying, in which case JR405 is installed and JR406 omitted.

Note: On the Power and Control board, there is a transistor circuit to inhibit the channel clock when TX Keying is present. This safety feature minimizes the chance of a faulty unit from keying on all channels as it scans.

Ignition Sense (U406)

6.30 The vehicle 12 volts, switched through the ignition switch, may be fed to the transistor in U406 if the optional ignition features are desired.

Tone Generation / Detection (U401, U407)

6.31 U401 is a proprietary Glenayre hybrid circuit with three functions:

(a) Tone Detection - it takes an incoming tone mixed with noise, squares it, and compares it to a fixed reference square wave frequency. The output (pin 19) goes low when the incoming tone is "present" within approximately plus or minus 25 to 35 Hz of the reference frequency.

(b) Tone Generation - it takes an incoming pulse train 8FGEN, and divides it by eight to synthesize a sine wave output on pin 9. If signal GLOAD (Generator Load) is high, the output tone stops, and JAM1 and JAM2 signals are loaded into a 4 bit Johnson counter which is used to

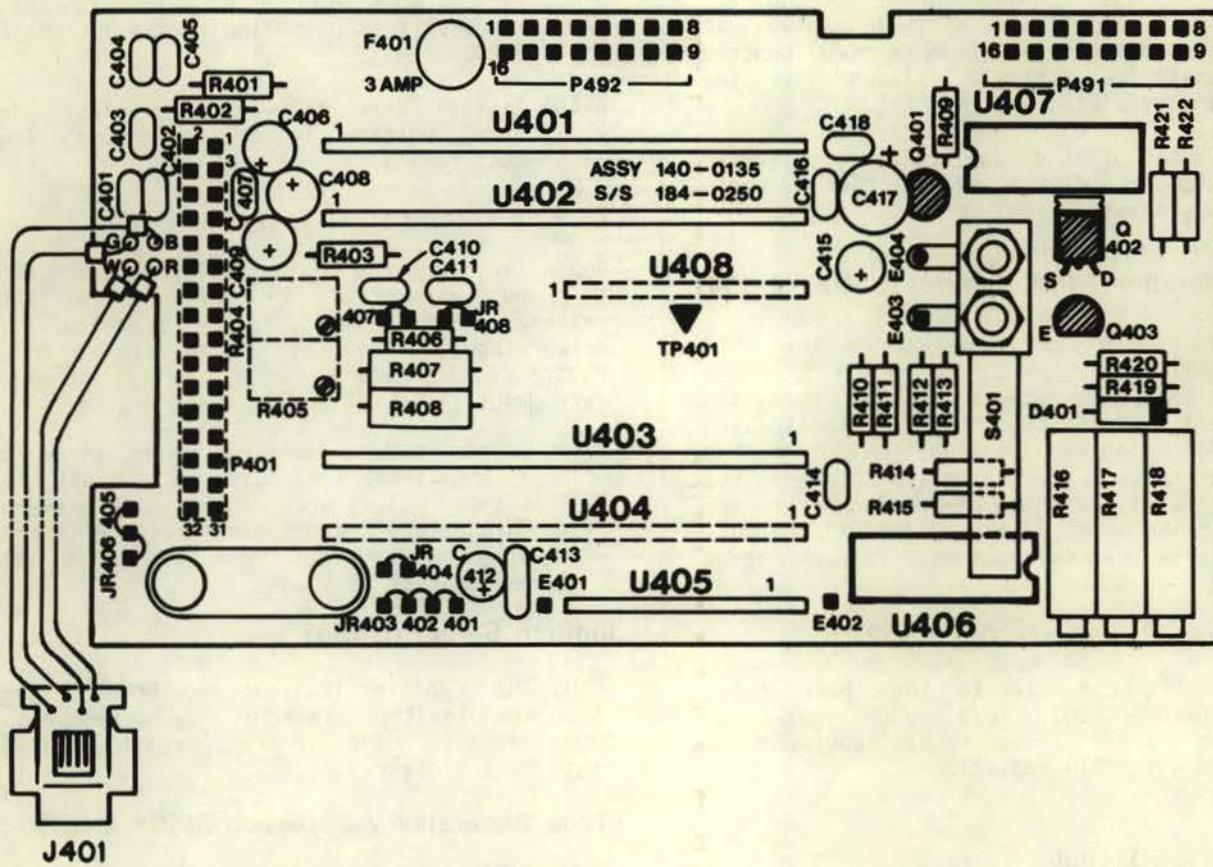


Fig. 34 – Interface Module – Card Assembly

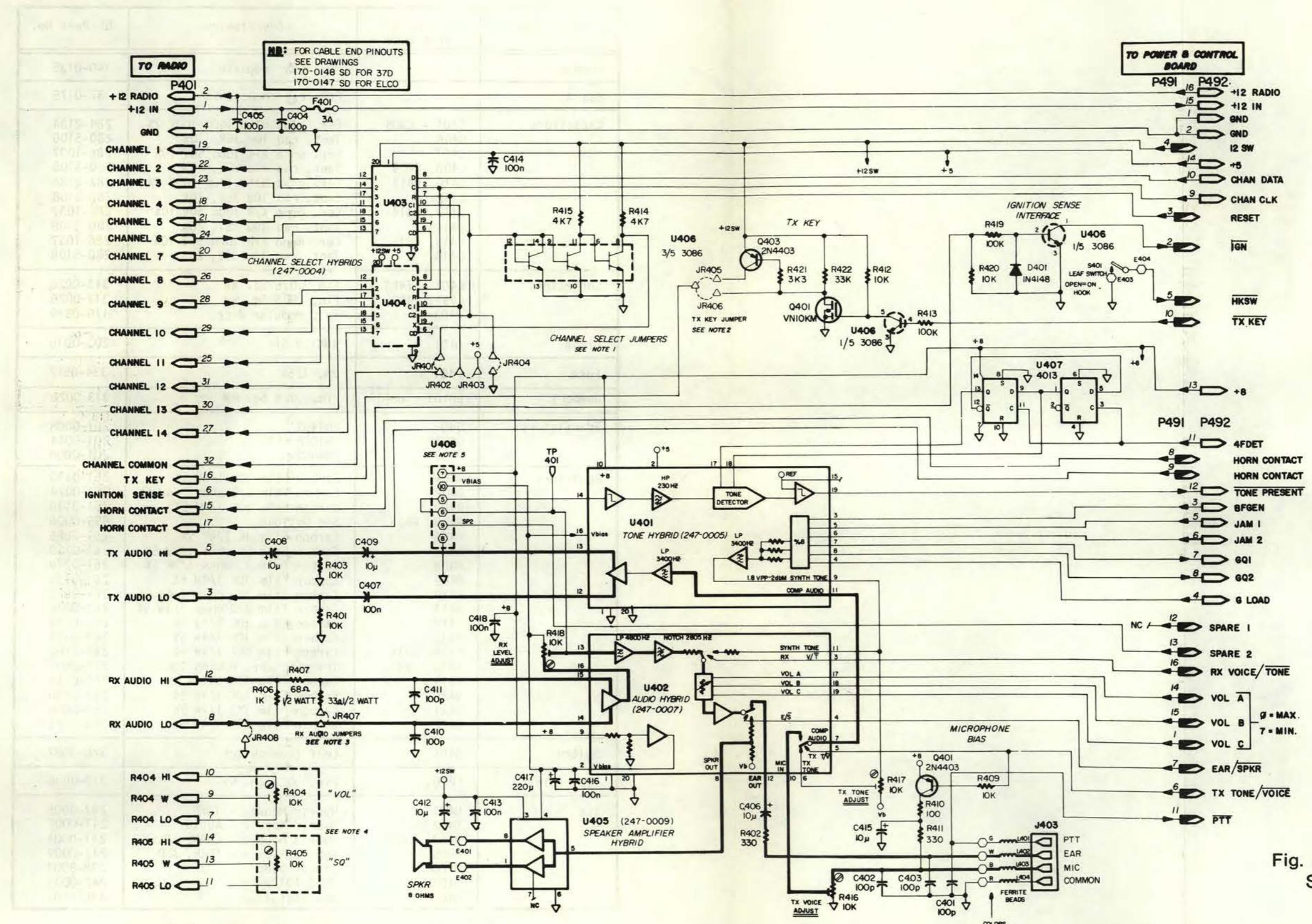


Fig. 35 - Interface Module Schematic Diagram

Part Type	Circuit Reference	Description	GL Part No.
Module	-	PCB Assy complete	140-0135
Board	-	PCB less components	137-0175
Capacitors	C401 - C405 C406 C407 C408, C409 C410, C411 C412 C413, C414 C415 C416, C417 C418	Cer. plat N750 100p 100V 2% Tant. rad 10u 35V, 20% Cer. mono X7R 100n 50V 10% Tant. rad 10u 35V, 20% Cer. plat N750 100p 100V 2% Tant. rad 10u 35V, 20% Cer. mono X7R 100n 50V 10% Tant. rad 10u 35V, 20% Cer. mono X7R 100n 50V 10% Tant. rad 10u 35V, 20%	284-2184 280-5108 286-1037 280-5108 284-2184 280-5108 286-1037 280-5108 286-1037 280-5108
Connectors	E401 - E404 E491, E492 J403	Pin, .025 Sq. WW Pin, .025 Sq. WW Tel. Modular Jack	313-0026 313-0026 170-0329
Diode	D401	1N4148 Sig.	203-0015
Fuse	F401	3A, 125V	334-0517
Jumpers	JR401 - JR408	Pin, .025 Sq. WW	313-0026
Transistors	Q401 Q402 Q403	2N4403 VN10KM FET 2N4403	201-0008 201-0044 201-0008
Resistors	R401 R402 R403 R404, R405 R406 R407 R408 R409 R410 R411 R412 R413 R414, R415 R416 - R418 R419 R420 R421 R422	Carbon Film 10K 1/4W 5% Carbon Film 330 ohms 1/4W 5% Carbon Film 10K 1/4W 5% See Options Carbon Film 1K 1/4W 5% Carbon Film 68 ohms 1/2W 5% Carbon Film 33 ohms 1/2W 5% Carbon Film 10K 1/4W 5% Carbon Film 100 ohms 1/4W 5% Carbon Film 330 ohms 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 4K7 1/4W 5% Trimpot, Cer. m-turn 10K Carbon Film 100K 1/4W 5% Carbon Film 10K 1/4W 5% Carbon Film 3K3 1/4W 5% Carbon Film 33K 1/4W 5%	261-0110 261-0074 261-0110 499-0006 261-0086 261-0780 261-0779 261-0110 261-0062 261-0074 261-0110 261-0134 261-0102 277-2509 261-0134 261-0110 261-0098 261-0122
Switch	S401	Leaf (hookswitch)	328-0082
Test Point	TP401	Pin, .025 Sq. WW	313-0026
ICs	U401 U402 U403, U404 U405 U406 U407 U408	Hybrid Module - TONE Hybrid Module - AUDIO Hybrid Module - CHAN. SELECT Hybrid Module - SPKR. AMP Linear 3086 CMOS 4013B Not installed	247-0005 247-0007 247-0004 247-0009 238-9007 242-0005 499-0001

Table 15 - Interface Module - Parts List

synthesize the sine wave. This is used for PSK, whereby JAM1 and JAM2 can be inverted to invert the phase of the outgoing tone. Signals GQ1 and GQ2 (Generator flip flop Q1, Q2) are outputs from the hybrid to effect PSK synchronization. Whenever Q1 and Q2 are different (low-high or high-low) then the synthesized sine wave is passing through its zero crossing point. This is used on the Power and Control Board to clock an eight state counter, which produces a 'PSK CLOCK' to the MPU every four cycles (eight zero crossings).

- (c) TX Audio Differential Output - it takes the composite TX audio on hybrid pin 11, and produces a differential output, to minimize alternator whine and other TX audio defects.

U407 is a dual 4013 CMOS flip flop connected as a "divide by four" counter, to divide the 4FDET reference pulse train (at the 8 volt level).

Audio Processing (U402)

6.32 U402 is a proprietary Glenayre hybrid circuit with the following functions:

- (a) TX Audio Differential Input - it provides a differential audio input to minimize RX audio defects.
- (b) Notch Filter - it provides a narrow deep audio notch filter around 2805 Hz, to allow the unit to be used in 2805 Hz "marked busy" systems.
- (c) Volume Control - it provides seven levels of audio gain (approximately 4dB steps), and an "off" position, for the RX audio, controlled by the three VOL bits A, B, and C from the audio control shift register on the Power and Control board (8 volt levels).
- (d) Audio Switching - it provides three "form C" electronic change over contacts, controlled by three (8 volt level) signals:
 - RX VOICE. TONE
 - EAR. SPKR
 - TX TONE. VOICE
- (e) VBIAS Generator - it generates a 4 volt bias from the 8V supply, for use as the "centre" of op amp circuits.

Speaker Amp (U405)

6.33 U405 is a proprietary Glenayre circuit which provides a drive for the 8 ohm speaker. The amplifier is powered from 12 volts, and provides a differential output to maximize the audio power. It features built in over-temperature and short circuit protection.

Microphone Bias (Q401)

6.34 The handset microphone is biased on via Q401 whenever the MPU selects "TX VOICE".

Miscellaneous

6.35 The fuse F401 is a 3 Amp plug-in microfuse, with two leads on 0.1" centres. The fuse is available under the following numbers:

Manufacturer	Part No.
BUSS	GMW 3A
LITTELFUSE	273003
SANO	SM1-3A
GLENAYRE	334-0517

6.36 R404 and R405 are 10K trimmers for volume and squelch adjustments of some radios - consult individual interface drawing.

6.37 Jumpers JR407 and JR408 provide the option to:

- (a) load the radio audio output with 100 ohms and a 9 dB pad
- (b) connect a local ground for those installations where the cable does not provide RX AUDIO LOW.

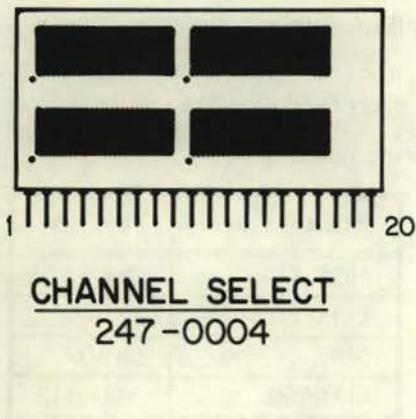
6.38 U408 hybrid is provided for future versions of the unit. At present, it is merely a row of holes in the PC Board.

6.39 The hookswitch closes when the handset is taken off hook, and the MPU takes appropriate action.

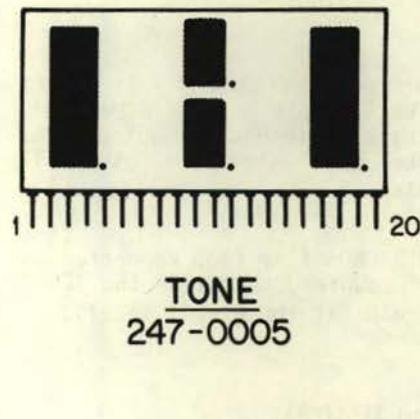
E. Hybrids

6.40 The unit features four types of proprietary Glenayre hybrid circuit:

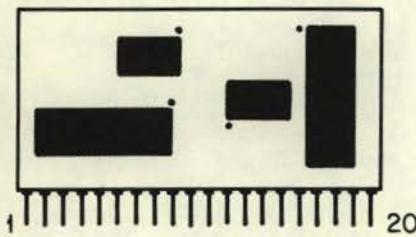
- | | |
|----------|--------------------------------------|
| 247-0004 | Channel Select (one or two per unit) |
| 247-0005 | Tone |
| 247-0007 | Audio |
| 247-0009 | Speaker Amp |



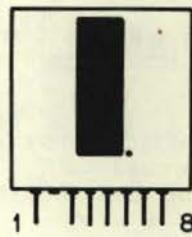
CHANNEL SELECT
247-0004



TONE
247-0005



AUDIO
247-0007



SPEAKER AMPL.
247-0009

Fig. 36 - Hybrid Modules - Pictorial View

6.41 The internal details of the hybrids are outside the scope of this document. Their functions are described in paragraphs 6.30 through 6.33. Hybrids are non-repairable in the field.

6.42 The appearance of each hybrid is shown in Fig. 36.

F. Pigtail Cable

6.43 The pigtail cable is approximately 48" long, and features a 2x16 "Amp-Modu" socket connector inside the GL 2020, and a

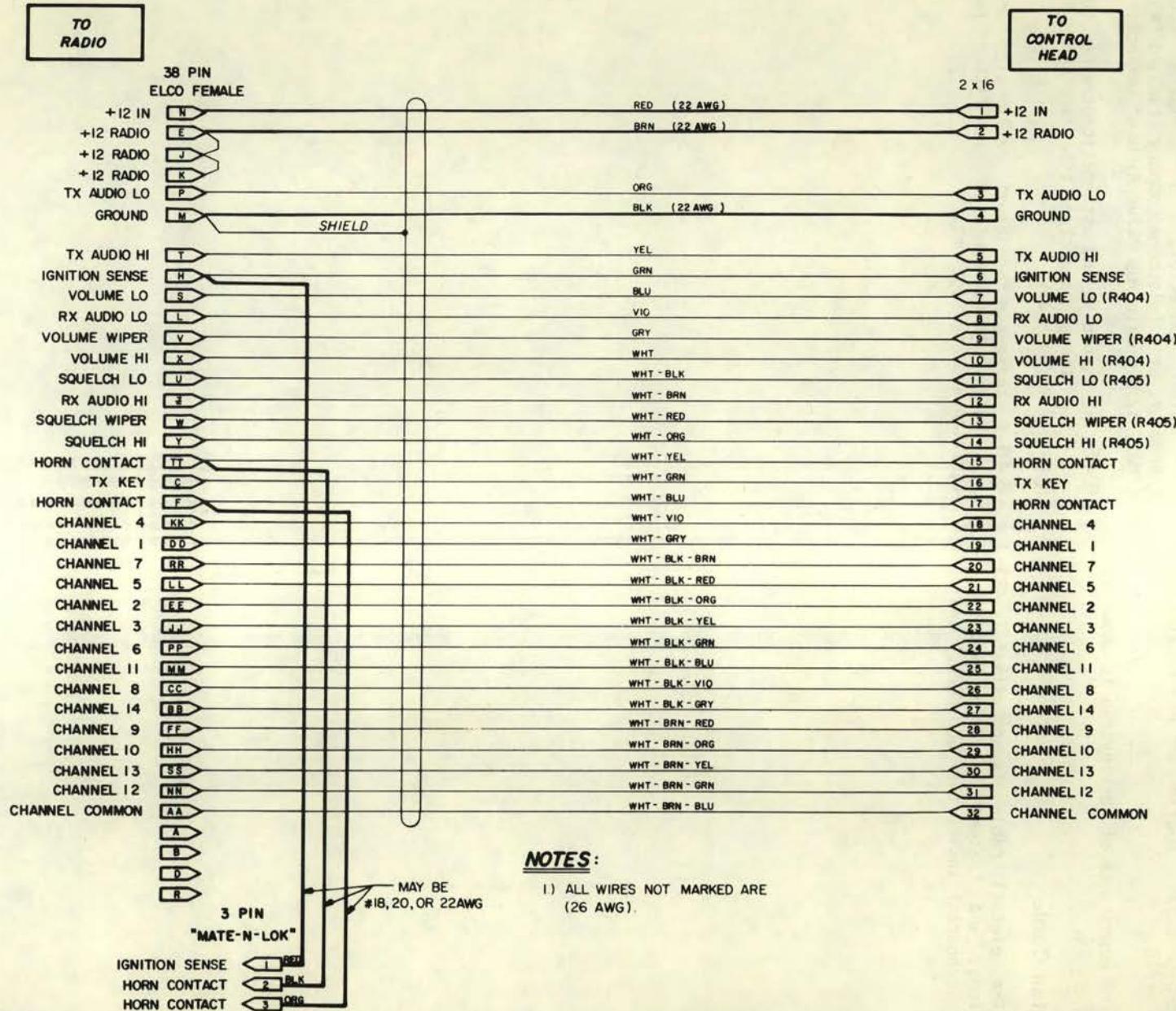
shielded, color coded 32 pin cable.

6.44 The other end is fitted with either a 37D male connector, a standard ELCO connector, or a Telephone Company standard "KS" ("MJ") 32 pin male Amp "Blue Ribbon" connector.

6.45 The assembly and schematic drawings for the three connector types are shown in Figs. 37 through 39.

6.46 A three pin "breakout" cable with Amp Mate "n" Lok connector is fitted for ignition and horn options.

Fig.37 - GL2020 ELCO Cable Assembly

**NOTES:**

- 1) ALL WIRES NOT MARKED ARE (26 AWG).

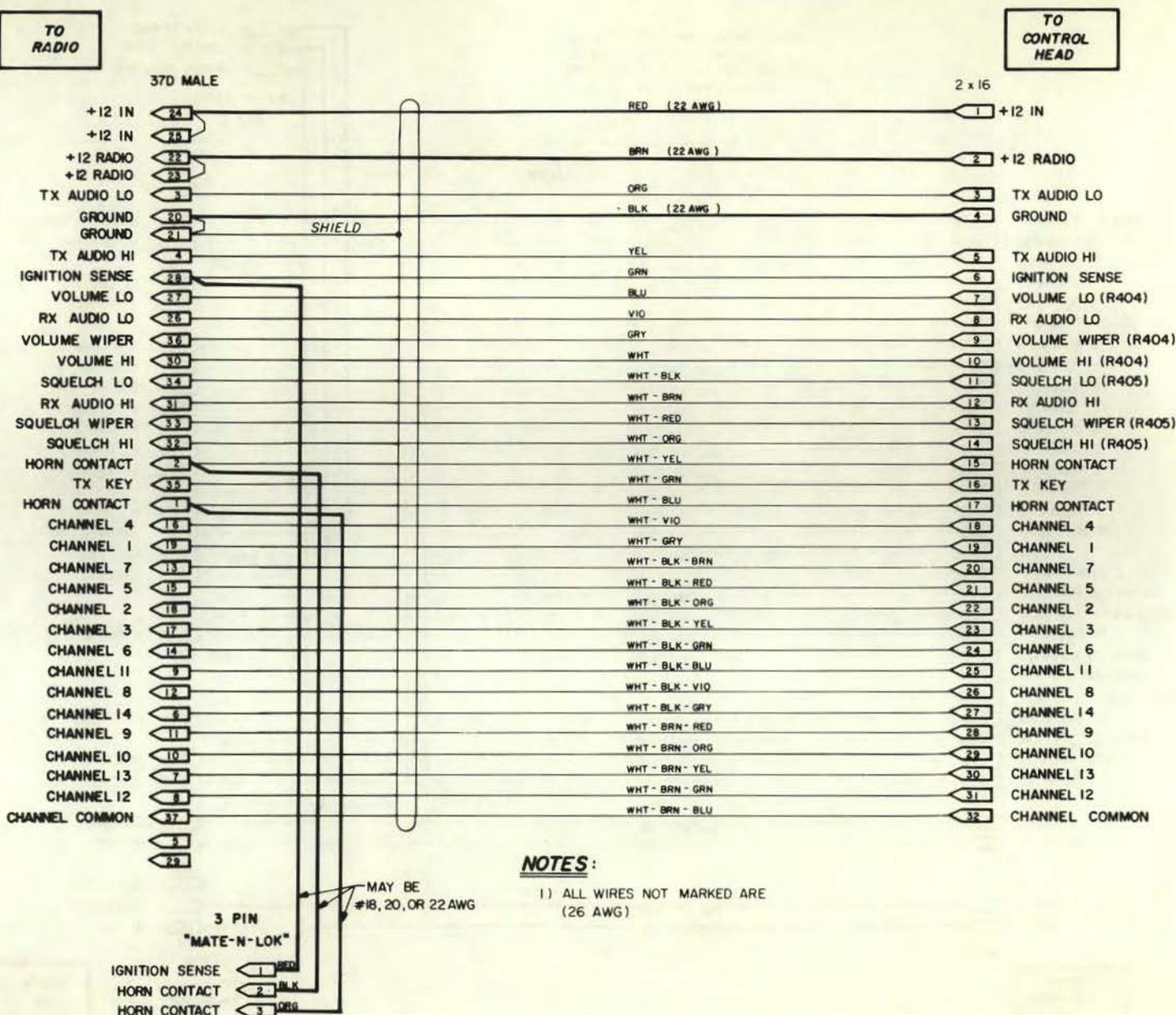
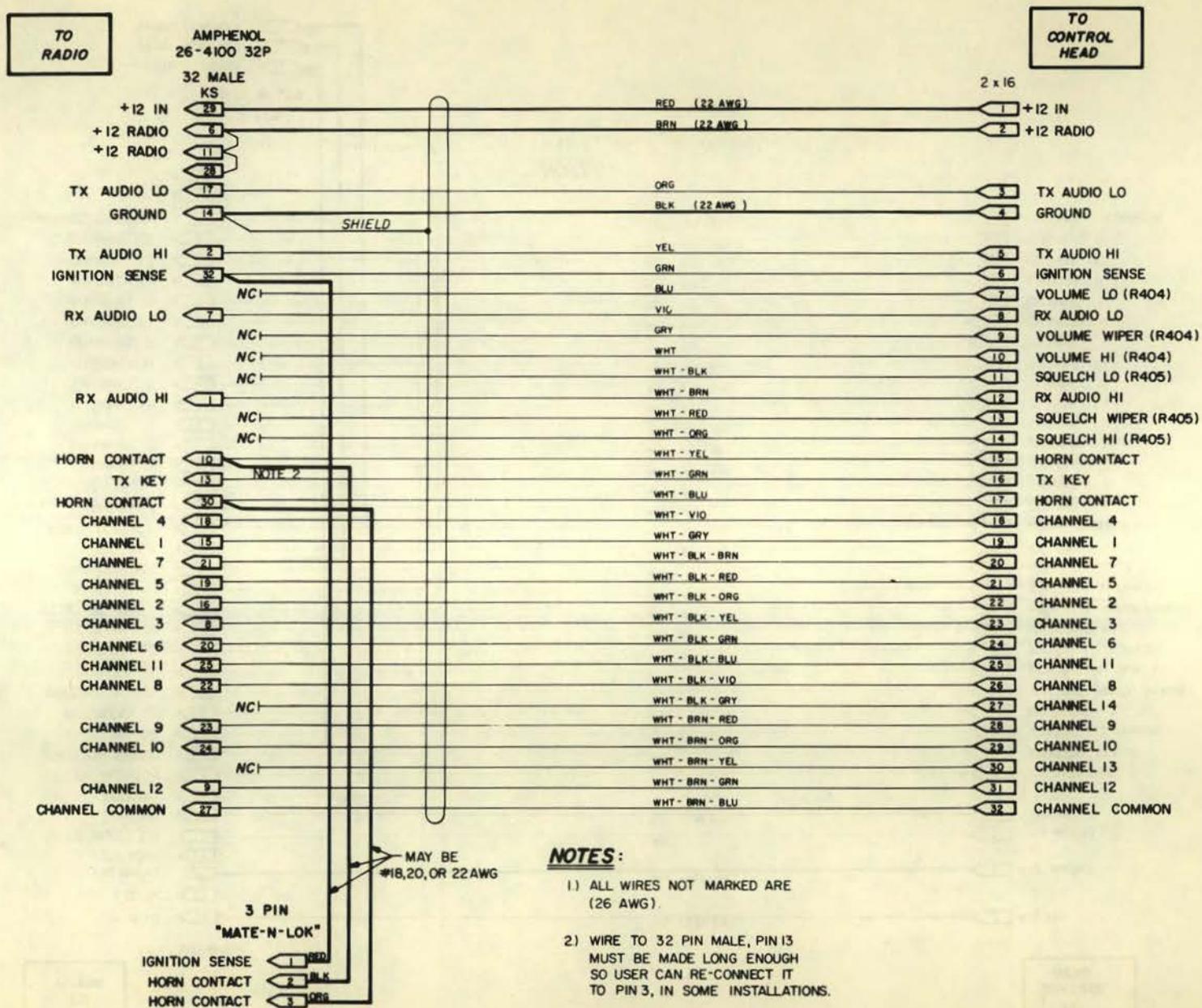


Fig. 38 – GL2020 37D Cable Assembly

Fig. 39 - GL2020 KS (MJ) Cable Assembly



Appendices

Appendix “A”

Bell Queuing Algorithm

"A" גזען אָ

Bell Quantum Algorithm

GENERAL

A1.01 The GL2020 "A" radiotelephone is compatible with the requirements of ATT publication 43301 (April 1981 issue), which describes the Bell requirements for IMTS mobile to land queuing. These requirements are such that the probability of "contention" (i.e. more than one mobile simultaneously attempts to seize a new idle channel) is minimized, while channel traffic efficiency is maximized. These desirable objectives are met at the expense of fairly long delays between mobile seizure attempts.

A1.02 The following attempts to summarize the GL2020 features with respect to the queuing algorithm requirements.

SCANNING

A1.03 The unit scans channels at 250ms per channel in the IMTS mode.

MARKED IDLE TONE VALIDATION

A1.04 Idle tone (2000Hz) is considered to be validated as "present" if it is detected continuously for 120ms. Once idle tone is validated, it is considered to be "absent" only if idle tone goes away for 120ms or more (shorter duration absences are considered to be "fades"). These definitions are implicit in the following references to idle tone "presence" or "absence".

CALL ORIGINATION

A1.05 If idle tone is present (validated, as above) when the user presses [S], or lifts the handset off hook, then a seize attempt is made immediately. Alternatively, if idle tone is absent at the time the call is originated, the unit queues for a free channel.

QUEUEING

A1.06 When the unit is "queued" the word [WAIT] appears on the display, and the busy tone is heard in the earpiece (even if the handset is on hook). The unit will queue for a maximum of 4 minutes. If no successful seizure attempt is made, the unit aborts the call after

the 4 minute time-out (and [WAIT] is erased from the display, a "boop" sound is heard in the speaker, and busy tone is removed from the earpiece). If the handset is off hook after the abort, then Receiver Off Hook tone is heard in the speaker.

A1.07 When the unit enters the queue, a random timer from 5 to 20 seconds (in 0.1 second increments) is started. While the random timer is counting the unit scans channels (at 250ms per channel) looking for valid idle tone, stopping on a channel if valid idle is detected, and resuming scanning if valid idle goes absent.

A1.08 When the random timer expires, the unit checks to see if valid idle is present, and make a seizure attempt if it is. If not, or if the seizure attempt is unsuccessful, the unit re-queues with a new random timer.

Note: The unit can receive calls while it is queued.

SEIZE ATTEMPTS

A1.09 The unit attempts to seize a channel on which valid idle tone is detected by transmitting IMTS "guard" tone for up to 350ms, followed by a 50ms burst of "connect" tone, followed by "guard" tone again. If the idle tone goes absent during the "guard" tone, the unit stops transmitting and re-queues. If idle tone does not go absent during the "connect" burst the unit re-queues. After idle drops during the "connect" burst, the unit waits for up to 1 second for seizure tone to be detected. Once detected, the unit waits for seize tone to go absent for 190ms at which point the unit sends ANI, having seized the channel successfully. If seizure tone is not detected within the 1 second, the unit re-queues.

CANCELLED CALLS

A1.10 If the queued call is cancelled, by the user pressing [C] or by going on-hook, the unit waits 2 seconds before acting on further call origination attempts by the user.

Appendix “B”

GL2020 Radio Interfacing Considerations

Appendix "B"

GI 5050 Radio Interference Considerations

INTRODUCTION

B1.01 The GL2020 has been interfaced with many popular radios, and no doubt will be mated with others from time to time. This document provides a general discussion of points to be considered when a new interface is to be engineered. The reader should glance at the interface to an existing radio, such as the Aerotron 600TT/800TT (Fig. 5) to gain familiarity with a typical interface.

B1.02 The radio/control head interface covers the following points.

- (a) Channel selection - format (binary or 1 of n)
 - coding (offset)
 - polarity (active high, low)
 - levels (5v, 10v, etc)
- (b) TX Keying line - electrical parameters
- polarity
- (c) TX Audio - levels/grounding
- deviation
- deviation limiting
- (d) RX Audio - levels/grounding
- Volume control
- squelch control
- (e) Power Switching
- (f) Cable considerations
- (g) Radio modifications

CHANNEL SELECTION

B1.03 The GL2020 has two unique capabilities which permit it to interface directly with all known types of channel selection - the "universal" channel select hybrid circuits U403/404, and the channel select programming capability in Technician Memory (7). (See paragraph 1.09.)

B1.04 In most radios the channel select lines are control signals from the control head to the radio to instruct the radio which channel should be selected. The lines may be of "1 of N" format i.e. one of the "N" lines is held at a different voltage from the others, or of binary format. Furthermore they may be of four types of polarity:

- Active low, Inactive open circuit
- Active low, Inactive high
- Active high, Inactive open circuit
- Active high, Inactive low

B1.05 In all known radios, with +12v negative ground vehicles, the "low" is at ground. The "high" however differs from one radio to the next. In most cases an active high (eg. 9.5v) is supplied on the channel common line from the radio. However the control head has the option of supplying 5v instead. For those radios which use 5v level control signals (to digital logic normally), it is customary for the radio manufacturer to supply pullup resistors in the radio, in which case the control head uses the "open circuit" option for a "high".

B1.06 Hybrid circuit U404 controls channel lines 8 through 14. Although these lines are unused in most binary controlled radios, the hybrid is still installed in the unit so as to make all units identical.

B1.07 The coding of binary controlled channel selection can not only be active low or active high, but may include an offset. For example, if the first channel "1" is to be selected, the radio may require binary "0000", i.e. an offset of minus 1. Radios requiring "1 of N" selection may also require an offset, if the radio crystals are installed in a non standard way.

Jumpers JR 401, 402, 403, 404

B1.08 These jumpers are installed as follows:

JR401: Only installed for certain Motorola radios whereby the channel select lines are control signals from the radio to the head (instead of the other way round, as is usual). DO NOT INSTALL EXCEPT FOR GLENAYRE ENGINEERED INTERFACES.

JR402: Installed if the "high" is supplied from the radio on the channel common line. This is normally done for those radios where the channel select line powers the individual crystal oscillator (like the Aerotron 600TT case).

JR403: Installed instead of JR402 in those cases where the active high is +5v supplied by the head. No known interfaces require this at present.

JR404: Installed where the "low" is to be ground. In all known cases to date, for consistency, JR404 is installed. This provides an active "low" for radios requiring a ground to select a channel, or it provides a ground to positively de-select a channel in the case where a positive voltage is required to select a channel.

#	Description	Yes
ADD 128	1 of N channel select output, as opposed to binary channel output.	
ADD 64	Active low (inverted) polarity.	
ADD 32	Channel display odd numbers only, 1, 3, 5, . . .	
ADD 16	Channel display 21 . . . 53	
ADD 8	Channel display 31, 32, . . . 63	
ADD 4	Negative offset	
ADD 2	Offset of 2	
ADD 1	Offset of 1	
Radio Channel Format Number		

Table 16 - Radio Channel Format Number

Note: Offset is the difference between the channel select output and the channel display. It is normally used for binary radios. For example, some radios require a binary zero to select channel one. In this case an offset of minus 1 is required, and the number 5 will be added to the contents of tech memory 7 (4 for negative, 1 for one).

TECHNICIAN MEMORY (M7)

B1.09 The Radio Channel Format number is stored in memory location M7. It is displayed and programmed as a number from 0 - 255. The definition of the radio channel format is laid out in Table 16.

TX KEYING LINE

B1.10 Most popular radios require a "ground" (through a transistor) to turn on the transmitter. In this "active low" case jumper JR406 is installed and JR405 is not. Note that transistor Q401 can sink up to 300mA with less than 1.5v drop, to drive older radios with inefficient keying relays, yet sink a few MA with negligible voltage drop when feeding logic circuits.

B1.11 Some radios require an active "high" 12 volt signal to key the transmitter. In this case JR405 is installed, JR406 is not. Note that many radios also require a positive (+12v) "TX ENABLE" signal from the control head, in order to enable the keying circuit. This signal may be tied permanently to +12v switched.

TX AUDIO

B1.12 The control head provides differential TX audio (mixed voice and tone on the one pair) to the radio, at levels approximating that of a normal carbon microphone. The circuit is AC coupled on both legs, and may drive a low resistance load in the radio (as is usually the case for radios incorporating carbon microphone biasing circuits).

B1.13 It is important that the level to the radio be kept fairly high, in the region of hundreds of millivolts, to overcome any possible degradation of the audio caused by ground noise display "hum", alternator whine, etc. The control head is factory set to a suitable level in the region of 0dBm (2 volts peak to peak) for a tone. Therefore the radio deviation control, if one is fitted, should be used to adjust the modulation of the transmitter. Do not confuse the deviation control with the deviation limit adjustment! It is important to note that a radio which is designed for low input levels, in the region of millivolts, may well suffer from audio degradation. In this case it is advisable to modify the radio by adding a series resistor or resistor divider to permit high level audio from the control head.

B1.14 It is most desirable, but not essential in most cases, that the interface incorporate a connection for the "TX Audio low" line, in order to provide true differential audio which can then reject ground noise to a large extent.

RX AUDIO

B1.15 The GL2020 requires only one audio signal pair - the "voice" audio which is de-emphasized in the radio. (Some other control heads require both tone and voice audio.) The RX audio must be permanently unsquelched (unmuted). In many radios there is no problem, as no squelch circuit is fitted. Of those radios which do have a squelch circuit, many have an internal squelch adjustment control. Some, however, require an external squelch control. In those cases R405 in the GL2020 is used to adjust the squelch circuit to be permanently unmuted.

B1.16 Many radios feature an earpiece amplifier with no volume control. In those cases the GL2020 "RX LEVEL" trimpot adjustment is used to set receive volume. In other cases the radio features an internal volume control or connects to external volume control R404 in the control head. Radios that are equipped with volume controls usually feature moderate or high power speaker amplifiers.

B1.17 Jumpers JR407 and JR408 are equipped as follows:

JR407 is installed only if the radio output is from a speaker amplifier. JR407 installation provides a 100 ohm load to the radio, and an attenuator (9dB) in the RX audio path to prevent overloading the GL2020 audio input amplifier.

JR408 is installed only if it is not possible or convenient to bring the radio receiver ground to the RX Audio Low input to the GL2020 differential amplifier in U402. The differential connection is most desirable to maximize audio quality.

POWER SWITCHING

B1.18 The GL2020 features no options for the switching of the power. The interface designer needs to understand how it works in order to connect the correct points in the radio cable.

B1.19 The GL2020 accepts unswitched +12 volts (which it uses to power the RAM supply and power on/off circuit) and switches it

through the power relay in the head, to power both the head and the radio receiver. The switched 12 volts usually feeds regulator(s) in the radio, but does not power the radio transmitter which is usually fed separately, due to the high current requirements.

B1.20 As mentioned above, some radios require a "TX Enable" 12v signal to enable the keying circuit. This is normally provided, where necessary, by permanently tying the "+12 switched" signal to the TX Enable radio input.

B1.21 The control head ground and radio ground are connected together to provide a power supply return.

B1.22 Some radios provide a filtered and/or fused "+12 unswitched" line to the control head. Others do not, in which case the control head power is fed from a "breakout" in the radio cable.

RADIO CABLE CONSIDERATIONS

B1.23 The control head features a short "pigtail" cable, fitted with a "37D", "ELCO", or "KS" connector. The cable to the radio is provided by the radio manufacturer, and must be fitted with a mating connector.

B1.24 The "37D" option is that used by the GL2020's predecessor the GL2000. The "ELCO" option is the de facto industry standard, although the interface designer must be cautioned that ELCO pin assignments may vary from one manufacturer to another (particularly channels 12, 13, 14, and the "low" or "common" signals of the audio paths). The KS option is for use when retrofitting Telco "KS" standard radios.

RADIO MODIFICATIONS

B1.25 It is very likely that zero modifications to the radio will be necessary in most cases. Likely exceptions are:

- (a) Supervisory Logic. If the radio already incorporates decoding logic it will need to be removed prior to connecting the GL2020. This often has many detailed ramifications and should only be attempted by capable personnel.
- (b) Audio "Commons". It may be necessary to provide signal access to the receiver and transmitter "grounds" for the differential audio and input, in order to minimize audio "hum" and "whine".

- (c) Volume and Squelch Controls. In rare cases it may be necessary to simulate external controls by the addition of series and/or parallel resistors, so as to provide unsquelched RX audio of the right level.
- (d) TX Audio Level. A radio which is designed for low level microphones may require to be modified by the addition of a series resistor or resistor divider, in order to permit audio levels from the head of "hundreds" of millivolts to overcome hum and whine.

